

FOREST RESEARCH IN INDIA,

1936-37.

PART I.—THE FOREST RESEARCH INSTITUTE.

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FOREST RESEARCH IN INDIA, 1936-37.

PART I.—THE FOREST RESEARCH INSTITUTE.

CHAPTER I.—GENERAL REVIEW.

The immediate value of investigations has, as hitherto, received special attention. Every effort has been made to keep in close touch with Provincial Forest departments. The value of research has long been recognised throughout the world and research in subjects connected with forestry is of special importance in India where the forests are so largely the exclusive property of the State.

The number of enquiries received continues to increase. With a few exceptions the enquiries are of a practical nature and are received from all over the world, a fact which shows that the value of the work at this Institute is widely recognised.

His Excellency the Viceroy and Lady Linlithgow paid a visit to the Institute during the year and at the end of their visit their Excellencies expressed their approval of all they had seen. The Hon'ble Sir James Grigg, Finance Member, and Sir Girja Shankar Bajpai, Secretary, Education, Health and Lands, also inspected the Institute during the year.

Among numerous visitors to the Institute mention must be made of Mr. Mellor, Managing Director, Messrs. The Titaghur Paper Mills Co., Ltd., who came to discuss the progress of research on problems which are being investigated for the paper industry, and Mr. G. Ullstrom of Mekaniska Werrstad Karlstad (Sweden) deputed by Messrs. The Orient Paper Mills Co., Ltd.

One of the important items of the year's work was the forest exhibit at the Agricultural and Industrial Exhibition held at Lucknow during the cold weather of 1936-37. The details of this exhibit which was arranged in co-operation with the Forest department of the United Provinces are given in the report of the Utilisation Branch.

Another outstanding event of the year was the holding at Dehra Dun of the Utilization Conference in March 1937. The Conference lasted

4 days and some very useful business was transacted, not the least important of which were the discussions concerning the future policy to be adopted with regard to the timber development campaign. The proceedings of the conference and the resolutions passed are now in the press. Gentlemen attending the conference were afforded full facilities for seeing the research being carried out at the Institute.

Silvicultural Branch.—The year under review was a good seed year for most of the indigenous species under investigation in the Demonstration Area. The monsoon broke comparatively early and continued fairly uniformly till September followed by occasional winter showers. The atmosphere was generally damper than the previous year which accounts for generally better results under artificial regeneration. Frost was less severe than in the preceding years but bad enough to kill back most of the young teak. It has become necessary to close the All-India teak seed origin experiment after the current year's observations on account of repeated frost damage.

More up to date methods for ascertaining the best material for seed covering in the nurseries on the lines of investigations in foreign countries have been under experiment.

Different species of bamboos, *Morus alba*, *Aleurites fordii* and *A. montana* have been put out to restock failed teak areas.

On the statistical side, collection of sapwood data for deodar, stem and stump analyses of *Acacia catechu* were carried out and a note was written up on the formation of heartwood in deodar.

The erosion model in the Silvicultural museum has been highly appreciated by officers and the public both here as well as at the Lucknow Exhibition.

Botanical Branch.—The systematic study of the Indian *Terminalias* of the section *Pentaptera* and of five species of the family *Dipterocarpaceæ* of forest importance was completed. Papers on three other Indian *Terminalias*, on a new genus of the *Connaracæ*, on the second part of recently introduced or otherwise imperfectly known plants from the Upper Gangetic Plain, on the oil-bearing seeds of the Chakrata, Dehra Dun and neighbouring Forest divisions, and on Indian plants reputed as fish poisons likely to yield efficient insecticides were also completed. The idea of conserving against change certain well-established botanical specific names of plants of forest importance was supported and a list of such names was submitted through the Imperial Forestry Institute, Oxford, to a Select Committee on Botanical Nomenclature for consideration. A large number of botanical specimens were identified during the year for Forest Officers and others in the provinces and advice given on technical matters. More than 2,500 specimens were incorporated in the Research Institute herbarium bringing up the total number to

near the quarter of a million mark. Donations and exchanges with other herbaria were continued as usual and suites of specimens sent out on loan to specialists engaged in the study of certain plant groups thus enhancing the value of our collections. Numerous samples of seed were supplied to many indentors in India and elsewhere and several larger indents for seed complied with.

The sal root disease, due to *Polyporus shoreae* and other associated fungi, was studied and an examination of specimens of the root rot and of cultural studies of the fungi was conducted. The roots of a number of local forest trees were examined in connection with the mycorrhizal investigation and mycorrhizal fungi were detected on sal and *Quercus incana*. Further progress was made in connection with the studies of the wood-rotting properties and pathogenic behaviour of fungi occurring on deciduous and coniferous trees. Inoculations on *Pinus excelsa* and *Cedrus deodara* with *Trametes pini* and *Fomes annosus* respectively showed signs of infection. Toxicity tests of certain wood preservatives were taken up and a beginning made with 'Ascu' preservative. Much progress has been achieved in the investigations relating to the life-history of various coniferous rusts in connection with which a large number of inoculation experiments were conducted and the biology of some of the stem and needle rusts of conifers have been worked out. Inoculation experiments made in connection with the investigations on *Dalbergia latifolia* canker fungus gave negative results. A large number of specimens of *Polyporaceæ* and species of *Armillaria* were incorporated in the Mycological herbarium which has also been enriched by the addition of several new and unrecorded rust specimens. Tours were made by the Mycologist in the Chakrata Forest division where valuable collections of fungi were made.

Entomological Branch.—An important part of the year's work was the study of the parasites of defoliators; especially of the defoliators of teak, sissoo and mulberry with a view to their multiplication and use in the biological control of these defoliators. This is the most important activity of the Entomological branch and it is hoped that practical results to forestry will be obtained from this work.

In continuation of the policy of publishing the accumulation of information available in our research files, a Forest Record on "The Biology of Bostrichidae" was published, this summarises all that is known of the Indian species of the family.

In systematic entomology steady progress has been made, over 700 species having been added to the reference collection. Special attention has been given to the weakest spot in systematics, the identification of immature stages, and several families of coleoptera were studied in detail. Much preliminary work has been done with lepidopterous larvae with the object of publishing the results in due course.

Utilisation Branch.—There are several important features worthy of special mention during the year under review. In the first place, the new Timber Development Section was inaugurated at the commencement of the year. This Section started its career by the Officer in Charge, Mr. S. Kamesam, making a tour to all provinces in India, with a view to finding out the best means of developing the timber resources of the country and collecting information on the output and sizes of the commercial woods available in the Provinces, and possible new markets for these woods. On his return, Mr. Kamesam proceeded to write up and issue a series of booklets on a variety of subjects connected with the utilisation of timber. Some 12 or more of these booklets have already been published and widely distributed.

On April 1st, 1937, the Timber Development Section was transferred to the Central Office under the direct control of the President of the Forest Research Institute.

Another important part of the year's work was that in connection with the Agricultural and Industrial Exhibition held at Lucknow during the cold weather of 1936-37. At a very late date it was decided that the Forest Research Institute should co-operate with the United Provinces Forest Department in staging a comprehensive exhibit consisting of an all-wood treated timber house of earthquake-proof design, together with displays of furniture of Indian woods and other exhibits illustrating the work of the Forest Department and the Forest Research Institute. In addition to the above, the Institute decided to erect two treated wood bridges (one being of 18 ft. span) as demonstrations of the possibilities of treated wood for such purposes. As time was very limited, the resources of the Branch were strained to the utmost in order to have the exhibits ready on the opening day, but it is satisfactory to report that the Forestry Court, including the treated timber house (which was of a two-storied design with 8 rooms), was one of the very few exhibits in the Exhibition which were ready on the opening day, when H. E. The Governor of the United Provinces made a personal tour of inspection through the house. At a later date, H. E. The Viceroy also visited the house and both Their Excellencies expressed their appreciation of this novel exhibit. The Forest Research Institute was awarded a Gold Medal for their exhibit, and Mr. Kamesam received a Gold Medal for his work at Asan.

In the other Sections, considerable progress was made on paper pulp and seasoning. The Paper Pulp Section was especially active during the year. This was the first year in which the Indian paper mills subscribed towards the expenses of the Section, and it is satisfactory to be able to report that considerable progress was made on the problems which were allotted to the Forest Research Institute by the Indian Paper Makers' Association. The investigations on the disintegration of bamboos

and that on Indian and foreign china clays were completed. The next investigation on the programme, namely the causes and prevention of discolouration in papers, was also started and is now well under way. Some very encouraging experiments were also carried out on the manufacture of kraft paper from bamboos, and the wood-pulp grinder for investigating the possibilities of manufacturing mechanical pulp from wood was installed towards the close of the year.

Another important investigation started by this Section was in connection with the suitability or otherwise of bagasse (crushed sugarcane) for making fibre boards for insulation and constructional purpose. A special grant was given by the Imperial Council of Agricultural Research to the Forest Research Institute to be used solely for this purpose.

The Seasoning Section was active in testing out the new furnace kiln and the oscillating process of kiln seasoning devised by Dr. Kapur. The laboratories of this Section have also been busy, and the evolution of a new type of cheap electric moisture metre was one result of their labours. Orders for more than a dozen of these metres were received immediately and arrangements were made for their manufacture locally at Dehra Dun.

The Timber Testing Section was fully occupied on routine testing and on special enquiries relating to such subjects as pole tests, the preparation of test pieces for aircraft purposes and the grading rules for teak squares.

The Wood Technologist, was, as usual, kept busy with numerous special enquiries and the routine work of timber identification and examinations for fungus.

The Woodworking and Veneer Sections worked at high pressure throughout the best part of the year, firstly in connection with the making and erection of the demonstration house, furniture, and bridges at the Lucknow Exhibition, and later trying to clear off the large accumulation of arrears of work which had piled up while the Exhibition work was in hand. Progress has been made towards interesting Indian commerce in the manufacture of high class hardwood veneers and it is hoped that such veneers will soon be available in India. Hardwood veneers of several Indian timbers are now on the European market. During the year there was a boom in Malabar rosewood especially in logs of a purple colour and very high prices were obtained. Some squares of U. P. Indian laurel (*Terminalia tomentosa*) were obtained to see what use could be made of this timber.

The activities of the Minor Forest Products Section had to be greatly reduced during the year. Nevertheless a considerable number of enquiries were dealt with and the cultivation of drug plants in the minor forest products garden was extended. A large number of enquiries

were received for scale drawings of the F.R.I. Portable Charcoal Kiln, and 34 sets of drawings were sent out in this connection.

The Utilisation Officer toured on the North Western Railway with the Inspector General of Forests, the Sleeper Control Officer, Northern Group, and the Timber Advisory Officer, in connection with the splitting of sleepers treated with water solutions. On this tour, many thousands of sleepers were examined in several different sections of the line, and a report on the whole subject was later published for departmental use. The Utilisation Officer also attended the Sleeper Pool Committee meeting at Delhi in November 1936, and went twice to Lucknow in connection with the Forest Department's activities at the Lucknow Exhibition.

Chemical Branch.—It was reported last year that the study of *Vitex negundo* and *V. peduncularis* had been taken up with a view to discovering the active principles responsible for the medicinal properties attributed to these plants in the Indian system of medicine. *Vitex peduncularis*, for instance, is a well known remedy for black water fever which is becoming more widely acknowledged by the medical profession. Our investigations have shown that it contains a glucoside and an alkaloid, the identity of which has not yet been established. From *V. negundo*, on the other hand, has been isolated a glucoside, constituents of which are glucose, parahydroxy-benzoic acid and an unidentified substance. To parahydroxy-benzoic acid may be attributed the antifebrile properties of this drug.

Of fish poisons under investigations the discovery of rotenone in *Millettia pachycarpa* is interesting and important.

The study of the indigenous sources of lauric acid, which has been mentioned in previous reports, has now been extended to *Litsua chinensis*, the fat of which contains 93 per cent. of trilaurin. Another oil that has been investigated during the year is from the seeds of *Ximenia americana*. The discovery of a new fatty acid which, we have designated as Ximenic acid is of interest.

Under the heading of essential oils has been mentioned the pleasant smelling oil from *Osyris tenuifolia* which grows in East Africa. The oil is very similar in odour to sandalwood oil but the chemical investigation indicates that the quantity of santolol is very deficient compared to Indian sandal oil. The odour in this case is probably due to the related alcohols, the identity of which has not yet been established.

CHAPTER II.—SILVICULTURE BRANCH.

I. Experimental Silviculture.

(i) NATURAL REGENERATION.

The study of annual seed production and fertility of individual *Anogeissus latifolia* trees (Expt. No. 44) was continued for the 9th year. All the trees produced a good crop of seed. Germination per cent. for the seed collected ranged from 0 to '07.

Seed crops from individual trees of *Shorea robusta*, *Tectona grandis*, *Pinus longifolia* and *Terminalia tomentosa* were also observed and recorded. It was a good seed year for the first three species although much of the sal seed was blown away by wind before collection. Practically no *Terminalia tomentosa* tree under observation produced any seed.

(ii) INVESTIGATIONS ON SEEDS.

(a) *Seed weighments and germination tests.*—During the year under report 126 weighments were made including 9 new species, and germination tests for 105 species were carried out. Some of their data were incorporated in the revised Forest Bulletin No. 41, which is now being issued as an Indian Forest Record, Silviculture Series, Vol. II, No. 5.

(b) *Seed storage.*—The following results of germination tests with seed stored for different periods in (i) sealed tins and (ii) gunny bags were obtained.

Species	Date of collection	Date of first test	STORING IN TESTS FOR						STORING IN GELLY BAGS FOR									
			1 year		2 years		3 years		4 years		1 year		2 years		3 years		4 years	
			Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	
<i>Acacia citharin</i>	June 10, '2	June 10, '2	67	55	14	6	13	13	13	1	1	1	1	1	1	1	1	
	{ February 1934	April 1934	50	57	77	77	77	77	77	22	1	1	1	1	1	1	1	
<i>Acacia xanthophloea</i>	May 19, '11	June 19, '11	72	72	72	72	72	72	72	59	59	59	59	59	59	59	59	
<i>Adina cordifolia</i>	June 19, '15	June 19, '15	70	31*	1	1	1	1	1	1	1	1	1	1	1	1	1	
<i>Bombax malabaricum</i>	April 19, '12	May 19, '12	72	72	72	72	72	72	72	1	1	1	1	1	1	1	1	
<i>Casuarina equisetifolia</i>	May 10, '11	August 1932	31	19	4	12	12	12	12	1	1	1	1	1	1	1	1	
<i>Casuarina equisetifolia</i>	March 10, '11	April 1931	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
<i>Cedrela odorata</i>	May 29, '35	June 1935	21	17	17	17	17	17	17	1	1	1	1	1	1	1	1	
<i>Cheirodendron trichotomum</i>	March 19, '13	April 1913	22	2	2	2	2	2	2	1	1	1	1	1	1	1	1	
<i>Citrus tetrandra</i>	September 1935	October 1935	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
<i>Dalbergia latifolia</i>	May 19, '11	June 19, '11	18	18	18	18	18	18	18	1	1	1	1	1	1	1	1	
<i>Diospyros laurentia</i>	May 19, '15	May 19, '15	44	15	15	15	15	15	15	1	1	1	1	1	1	1	1	
<i>Denudariopsis stricta</i>	May 1933	June 19, '1	65	77	77	77	77	77	77	1	1	1	1	1	1	1	1	
<i>Dipteryx oleifera</i>	April 1915	April 1915	77	75	75	75	75	75	75	12	12	12	12	12	12	12	12	
<i>Melia azedarach</i>	February 1912	April 1912	10	90	71	71	71	71	71	24	24	24	24	24	24	24	24	
<i>Ougea ovalifolia regalis</i>	May 1935	May 1935	57	57	57	57	57	57	57	1	1	1	1	1	1	1	1	
<i>Schleichera siamensis</i>	August 19, '12	August 1932	11	15	15	15	15	15	15	1	1	1	1	1	1	1	1	
<i>Terminalia arjuna</i>	May 1935	May 1935	67	11	11	11	11	11	11	1	1	1	1	1	1	1	1	
<i>Terminalia chebula</i>	February 1931	June 1933	51	0*	0*	0*	0*	0*	0*	1	1	1	1	1	1	1	1	

* per 100 or, if needed.

Similar storage tests have been commenced during the year for *Acacia arabica*, *Morus alba* and *Swietenia macrophylla*.

(iii) INVESTIGATION ON SEEDLINGS.

The morphological seedling studies as reproduced in Troup's Silviculture of Indian Trees were completed for the following 11 species :—

Cullenia excelsa, *Diospyros tomentosa*, *Derris robusta*, *Ficus glomerata*, *Lophopetalum fimbriatum*, *Olax scandens*, *Olea cuspidata*, *Phæbe haincsiana*, *Pinus caribaea*, *Stereospermum xylocarpum*, and *Vitex peduncularis*. Sketches of the following four other species were also partly drawn :—*Altingia excelsa*, *Cynometra polyandra*, *Dichopsis polyantha*, and *Ichnocarpus assanicus*.

(iv) INVESTIGATIONS ON TREES AND CROPS.

(a) *Seasonal course of height growth*.—The investigation was continued for 13 common Indian species,—weekly or periodical measurements being taken throughout the year.

(b) *Phenological data*.—Observations were recorded on 13 common species. Collaboration with the Provincial Silviculturists was continued. Their data are being analysed with a view to issuing a note on the subject.

(c) *Inheritance of individual characters*.—Two more experimental plots of reputed figured and unfigured *Terminalia crenulata* plants have been added to the two existing ones. *Pinus longifolia* plots, raised for determining whether high resin yielding capacity is a hereditary character, were maintained.

(d) *Inheritance of climatic racial characters*.—The All-India teak seed origin experiments dealing with 11 origins were maintained. Every plant was again frosted to the ground, and it has been decided to discontinue this set of plots at the end of 1937, after recording morphological differences between the plants of the different origins. Differences in appearance of bark and colour of foliage between Burma and local origins of *Acacia catechu* reported in previous years persisted throughout the year under report.

(e) *Inheritance of physiological race characters*.—The small plantations of different forms of *Butea* and *Schleichera trijuga* raised for examination for lac culture were more or less frosted again this year. As it has since been reported from Ranchi that it would not be possible to raise lac at Dehra Dun, morphological differences will only be studied.

(f) *Soil quality class indicators*.—The ecological quadrats in plantations of different important species in the Demonstration Area were maintained and mapping done as usual.

(g) *Congestion in bamboo clumps*.—Two different treatments namely topping and stripping of new culms were applied to selected clumps of *Dendrocalamus strictus* early in the cold weather to determine the effect on congestion of the clumps. These treatments are intended to simulate, under control, damage by elephants. It is too early yet to draw any conclusions.

(h) *Root competition*.—Experiments on the following species are in progress :—

Shorea robusta.—(a) The experiment was laid out in 1933. The figures for 1933-34 were analysed and the difference in diameters between two treatments, viz., control and elimination of root competition indicated a significant increase in diameter growth in the plots where root competition was eliminated. Subsequent measurements are being analysed at the Statistical Laboratory, Calcutta, by up to date methods.

(b) Line sowings of sal were done at right angles to the East to West edge of a crop of big sal poles in 1933. The lines were 6 feet apart, and were sown thinly and thickly alternately, to study the effect of competition between seedlings themselves. Alternate pairs of lines have been trenched annually to a depth of 18" cutting through all roots from the adjoining wood. Data are under computation.

Pinus longifolia.—Same as sal (a) above. The data have not been worked out yet.

Cedrela toona.—Comparable pairs of young plants growing under the same conditions were selected in 1936. The root competition from the surrounding growth was eliminated by trenching all round one of the plants in each pair and isolating them by galvanised iron.

Phæbe lanceolata.—As *Cedrela toona* above.

Holoptelea integrifolia.—Same as *Cedrela* and *Phæbe* above except that this has been trenched in sets of three plants.

Results.—No significant differences in growth were observed in the case of *Cedrela toona* and *Holoptelea integrifolia*. The *Phæbe* measurements were upset by insect attack.

(i) *Thinnings in young plantations*.—The five sets of experiments in replicated series in the younger *Pinus longifolia* plantations in the Demonstration Area were maintained. The factors under investigation are (i) comparison of different grades and methods of thinning (C-grade, D-grade and "free thinning"), (ii) to compare the effects of different

dates of first thinning, (iii) comparison of the effects of different early espacement on growth and form, (iv) comparison of thinnings to different fixed numbers of stems per acre, and (v) comparison of different thinning cycles. It is too early to report any results so far.

(j) *Pruning versus natural cleaning*.—Two investigations in *Shorea robusta* and *Pinus longifolia* crops to compare the effects of pruning *versus* natural cleaning on growth and timber quality are in progress.

(k) *Twist in Pinus longifolia*.—The experiments of (a) attempting to induce twist and (b) studying the heredity of twist in *Pinus longifolia* are being continued. Plants raised from X-rayed seed are progressing and will soon be large enough for observation of twist.

(l) *Controlled burning*.—An experiment is in progress to determine the effects of early burning in young *Pinus longifolia* plantations.

(v) ARTIFICIAL REGENERATION.

Weather conditions affecting the results obtained were as follows :—

The 1935 monsoon arrived rather late, the first showers falling on the 2nd July. Rains were, however, regular up to the 3rd week of September. Then followed a dry period and there was practically no rain up to the beginning of February 1936.

The 1936 monsoon broke much earlier than usual, in the beginning of June, and continued up to the end of September. Thus the plants had a much longer rainy period than usual. There were copious winter rains also in December when the winter stump planting was done. Frost occurred, as usual after the winter rains, but was not as severe as in the last few years. On the whole it was a damp year.

(a) *Line sowings*.—The following species were tried in the open as well as in shade during 1936 :—

Albizia stipulata, *Boswellia serrata*, *Cordia myxa*, *Eugenia jambolana*, *Kydia calycina*, *Iannea grandis*, *Morus alba*, *Swietenia macrophylla* and *Terminalia myriocarpa*; of these *B. serrata* and *T. myriocarpa* failed; the others did well. Plants were more or less affected by frost, especially those of *S. macrophylla*.

(b) *Rains entire planting in the open*.—The following species were tried in 1936. The survival per cent. at the end of the year is given in brackets. The plants have not yet been through a hot weather. *Cedrela toona* (74), *Holoptelea integrifolia* (78), *Lagerstramia parviflora* (55), *Morus alba* (82), *Machilus gamblei* (96), *Swietenia macrophylla* (6) and *Terminalia citrina* (96).

For the species planted in 1935, the following are the survival per cent. at the end of the 1st and 2nd growing seasons respectively. *Boswellia serrata* (8-0), *Cedrela toona* (61-closed), *Cordia myxa* (84-58), *Diospyros tomentosa* (78-55), and *Terminalia paniculata* (56-36). Casualties in the first two species were mainly during the hot weather.

(c) *Rains entire planting in cleared lines under shade.*—The following species were planted in 1936,— the survival per cent. at the end of the year being given in brackets.

Cedrela toona (69), *Holoptelea integrifolia* (59), *Lagerstroemia parviflora* (11), *Lophopetalum fimbriatum* (99), *Morus alba* (82), *Machilus gamblei* (98), *Swietenia macrophylla* (62), and *Terminalia citrina* (92).

As regards the species tried in 1935 the following are the survival percentages at the end of the first and second growing seasons respectively :—

Cedrela toona (58-46), *Cordia myxa* (98-98), *Cryptomeria japonica* (33-29), *Diospyros tomentosa* (80-68), *Terminalia paniculata* (62-52) and *Boswellia serrata* (0). The last species died on account of heavy rains and drip soon after planting.

(d) *Winter entire planting in the open and under shade.*—Of the species planted out during February 1936 only *Terminalia chebula* survived in the open 66 per cent. at the end of the first season. The other two species *Pterospermum acerifolium* and *Boswellia serrata* died during the hot weather of that year.

The following species were put out during February 1937 :—

Anthocephalus cadamba, *Eugenia grandis* and *Morus alba*.

(e) *Winter stump planting in the open and in cleared lines.*—At the end of the 1st growing season, the survival percentages for *Acacia catechu*, *Prosopis juliflora*, *Stereospermum suaveolens* and *Terminalia tomentosa* tried in 1936, were 26, 34, 98 and 54 in the open.

The following species were planted during 1936-37 cold weather:—

Acacia modesta, *Cassia siamea*, *Hovenia dulcis*, *Litsaea polyantha*, *Mallotus philippinensis*, *Swietenia macrophylla* and *Terminalia paniculata*.

(f) *Rains stump planting in the open.*—The species put out in 1935 are mentioned below with their survival percentages at the end of the 1st and 2nd seasons respectively :—

Boswellia serrata (38-48), *Bauhinia purpurea* (96-94), *Grevillea robusta* (92-76), *Lagerstroemia flos-reginae* (100-97), *Juglans*

regia (95-closed), *Prosopis spicigera* (90-64), *Pongamia glabra* (100-80), *Terminalia chebula* (100-22), *Terminalia myriocarpa* (12-closed), and *T. arjuna* (4-closed). Of these *Juglans regia* died of frost and subsequent drought, and *Terminalia myriocarpa* of frost alone.

With the species tried in 1936 the following results were obtained at the end of the year, the figures in brackets giving the survival per cent.:—

Cassia siamea (100), *Cedrela australis* (100), *Cordia myxa* (100), *Hovenia dulcis* (44), *Lagerstramia parviflora* (98), *Prosopis spicigera* (99), *Pterospermum acerifolium* (100), and *Terminalia paniculata* (98).

(g) *Rains stump planting under shade*.—The species put out in 1935 showed the following survival percentages at the end of the 1st and 2nd seasons respectively :—

Bauhinia purpurea (70-68), *Grevillea robusta* (55-35), *Lagerstræmia flos-reginae* (100-98), and *Pongamia glabra* (98-44). Experiments with other species mentioned in the last year's report were closed down as the plants had either died in the 1935-36 frost or in the subsequent dry weather. The following species were tried in 1936, their survival per cent. at the end of the season being given in brackets :—

Cassia siamea (68), *Cordia myxa* (98), *Eugenia grandis* (65), *E. operculata* (99), *Hovenia dulcis* (70), *Lagerstramia parviflora* (96), *Pterospermum acerifolium* (98), *Sympidium febrifuga* (20), *Terminalia paniculata* (80), and *T. tomentosa* (88).

(h) *Storage of stumps before planting*.—The 1935 experiments with *Acacia catechu* and *Eugenia jambolana* stored in moist sacking under thatch shelter for 0, 4, 7, 10 and 13 days shewed the following results at the end of the 2nd growing season :—

Acacia catechu.—The survival percentages were 56, 46, 32, 20, and 22, with corresponding average heights of 40.6", 37.9", 36.8", 39.5" and 29.5".

Eugenia jambolana.—The survival percentages were 68, 90, 86, 80, and 80 with corresponding average heights of 10.6", 10.4", 11.4", 10.7" and 10.3".

In 1936, *Cedrela toona* and *Terminalia tomentosa* were tried under similar conditions.

Cedrela toona.—250 stumps of different diameters prepared on 14th June 1936 were planted out in comparable sets of 50 stumps after storage

up to 13 days in moist sacking under thatch shelter. Rain was rather irregular up to 20th June 1936 but was continuous thereafter. At the end of the growing season the survival percentages were 98, 100, 96, 100, and 91 with corresponding average heights of 10.3", 11.5", 13.2", 12.6", and 11.6" for stumps stored for 0, 4, 7, 10 and 13 days respectively.

Terminalia tomentosa.—The number of stumps and the initial treatment were the same as for *Cedrela toona* but the date of preparing the stumps was 22nd June 1936. At the end of the year the survival percentages were 76, 78, 68, 72 and 69 with corresponding average heights of 6.6", 8.2", 7.1", 7.1" and 8.0" for stumps stored for 0, 4, 7, 10 and 13 days respectively. Rains were continuous up to the end of the month.

(i) *Early planting of stumps without irrigation*.—The fortnightly planting of 25 *Acacia catechu* stumps was started from 10th January 1936 in the open and continued up to 11th June 1936. The survival percentages were 8, 8, 8, 36, 12, 12, 0, 0, 12, 76, 100, and 88 with corresponding average heights of 32.5", 38.5", 31.0", 21.1", 31.7", 32.7", 0, 0, 21.7", 23.9", 27.3" and 19.9" for sets 1 to 12 respectively. Some occasional showers during the hot weather account for the varying results. The driest month was April and planting during this month was a complete failure. Planting done just before or at the break of the monsoon gave the best results.

(j) *Comparison of nursery stock and natural seedlings*.—The 1935 experiment with *Eugenia jambolana* showed survival percentages of 70 for nursery and 68 for forest plants with heights 10.3" and 8.6" respectively at the end of the 2nd season as against the survival percentage of 96 and average height of 7.6" in the first year for both the sets. *Eugenia jambolana* was again repeated in 1936 and the survival percentages at the end of the year were 98 and 68 for nursery and forest plants respectively with no significant difference in their heights. It appears from the above that, if transplanted, forest plants suffer by comparison with plants raised in the nursery.

(k) *Comparison of nursery and forest stumps*.—*Bauhinia variegata* planted in 1935 shewed the survival per cent. of 98 for nursery grown stumps and 80 for forest stumps, their average heights being 23.2" and 19.5" respectively at the end of the 2nd season.

The experiment was repeated with *Bauhinia variegata* and *Eugenia jambolana* in 1936. The survival per cent. of *B. variegata* was 100 for nursery stumps and 94 for forest stumps with average heights of 13.7" and 7.6" respectively at the end of the year. *Eugenia jambolana* shewed a survival per cent. of 100 for nursery stumps and 98 for forest stumps with average heights of 5.3" and 6.1" respectively at the end of the season.

(l) *Comparison of sowing, transplanting and stumping.*—The species tried from 1934 to date and the results obtained are summarised below:—

Year of planting or sowing.	Species.	Method (sowing or planting).	SURVIVAL PER CENT. AT THE END OF THE YEAR			Average height at the end of 1936 (Inches).	REMARKS.
			1934	1935	1936		
1934	<i>Eugenia jambolana</i>	Direct sowing . .	91	5	Discontinued in June 1936 as survival was below 20 per cent.
		Entire transplanting . .	60	..	..	..
		Stump planting . .	78	83	..	..
	<i>Stereospermum suaveolens</i>	Entires in crow-bar holes	53	8	8	47	
		Entire in standard pits	60	13	16	34	
		Stump planting . .	93	100	100	30.7	
1935	<i>Acacia catechu</i>	Direct sowing	83	75	32.0	
		Entire transplanting . .	..	63	45	24.4
		Stump planting . .	..	78	65	33.7
	<i>Bombax malabaricum</i>	Direct sowing . .	..	70	..	..
		Entire transplanting . .	..	93	50	60
		Stump planting . .	..	90	90	15.1
1936	<i>Cedrela toona</i>	Entire transplanting	95	10	20.5	Discontinued in June 1936 as survival was below 20 per cent.
		Stump planting . .	..	100	00	31.4
		Direct sowing . .	..	88	..	..
	<i>Pteroppermum nervifolium</i>	Entire transplanting . .	..	100	..	..
		Stump planting . .	..	65	..	..
		Direct sowing . .	..	..	95	12.5
	<i>Acacia catechu</i>	Entire transplanting . .	..	..	70	6.7
		Stump planting . .	..	..	89	10.1
		Direct sowing . .	..	..	100	5.6
	<i>Bombax malabaricum</i>	Entire transplanting . .	..	..	95	3.9
		Stump planting . .	..	..	98	8.5
		Direct sowing . .	..	..	80	3.8
	<i>Cedrela toona</i>	Entire transplanting . .	..	..	95	4.4
		Stump planting . .	..	..	100	18.0
		Direct sowing . .	..	..	80	6.0
	<i>Cellis tetrandra</i>	Entire transplanting . .	..	..	88	14.7
		Stump planting . .	..	..	100	15.7
		Direct sowing . .	..	..	..	..

(m) *Araucaria* plantations.—The *A. cunninghamii* plantation is continuing well and has reached a maximum height of 12'-6" at the end of 5 years.

This year 10 baskets of artificial farmyard manure seemed to have given the best results so far ; and the green manuring of *Crotolaria juncea* was decidedly better than that of *Cassia tora* and *Lucerne*.

(c) *Best material for seed covering in nursery* (Experiment No. 92).—With a view to study what easily available material is most efficacious as regards quickness and uniformity of germination of different types of seeds, the following were used :—

Materials—

- A. Well washed coarse sand.
- B. Sifted leaf litter.
- C. Artificial farmyard manure.
- D. Sifted nursery soil (control).

Seeds--

1. *Cedrela toona*.
2. *Terminalia arjuna*.

Sowing was done on 10th June 1936 for No. 1 and 13th May 1936 for No. 2.

Technique—

The seed covering materials were laid in replicated plots. For *Cedrela toona* A, B, C coverings were $\frac{1}{5}$ ", $\frac{1}{4}$ " and $\frac{1}{2}$ " thick respectively and D, 1½ times the seed thickness ; but, for *Terminalia arjuna* all the coverings were $\frac{1}{8}$ " thick. *Cedrela toona* was uniformly sown in lines using equal quantities of seed whereas seeds of *T. arjuna* were counted and equal numbers used in each unit. The experiment was combined with shading so that 4 of the beds were shaded and 4 unshaded using a latin square layout.

Results.—The following results were obtained up to the end of the year :—

Terminalia arjuna.—Germination per cent. was better in the unshaded beds on the whole, but sifted leaf litter in the shaded set gave the best results. There was, however, very little difference in the germination per cent. obtained with the different coverings as is to be expected with a large seed. Height growth by the following cold weather was better in the unshaded beds, and especially so in the case of B (leaf litter covering) and C (artificial farmyard manure).

Cedrela toona.—Germination was uniform and development better in the shaded beds. Coarse sand gave the best results in the open and leaf litter in the shade. Survivals were very definitely better (2 to 4

times as many) in the shade than in the open. Coarse sand gave the best survivals and ordinary nursery soil next best in both shade and open. Height growth at the end of the year was more or less the same for all coverings with or without shade.

The experiment is being repeated.

(vii) MISCELLANEOUS.

A small plantation of *Broussonetia papyrifera* and one of *Horaria dulcis* have been raised in the Experimental garden,—the former for testing for paper pulp and the latter for studying the natural cleaning of branches and straightness of the bole under plantation conditions.

(viii) RECLAMATION AND AFFORESTATION.

(a) *Miscellaneous Working Circle*.—Compartments with *Tectona grandis* which have failed on account of frost year after year are being re-afforested with *Acacia catechu*, *Bambusa polymorpha*, *Cedrela toona*, *Dendrocalamus strictus*, *D. longispathis* and *Morus alba*, and up till now 14 such compartments have been completed. All these are found to be frost hardy in this locality, especially the last named species.

Dendrocalamus strictus was sown in lines supplemented by planting of nursery plants pruned at 2 ft. length of the stems. *D. longispathis* was transplanted at 10'×10' from the nurseries, stems having been pruned at a height of 2 ft. as in the case of *D. strictus*. *Bambusa polymorpha* was sown in lines. Germination was excellent and plants at the end of rains were up to 1 ft. in height.

The rosewood plantation in two adjoining compartments has been regularly pruned. This forms a small compact promising block of rose-wood.

Plants of *Aleurites fordii* and *A. montana* have been raised successfully in a small *taungya* plot in one of the cleared compartments. Preliminary trials with *Pinus caribaea* by transplanting 3 months old seedlings were not successful chiefly owing to damping off during the rains. A 15-acre plot, now under *taungya* crops, will be stocked with *Pinus longifolia* in 1937 rains to raise crops for an extensive replicated set of thinning experiments. Five more compartments have been leased out for *taungya* cultivation and will be used for further trials with new species.

(b) *Sal Working Circle*.—Mixed line sowings of *Dalbergia sissoo*, *Dodonea viscosa* and *Bauhinia* spp. were made in compartments where young sal was suffering from frost, the main idea being to cover the ground with quick growing frost hardy species so that these might

afford the existing sal protection in the future. Frost occurred this year as usual, but damage was limited to small and unprotected plants only.

(c) *Chir (Pinus longifolia) Working Circle*.—Blanks in the compartments with Naini Tal origin and in the plot in front of the Branch officers' bungalows (Nos. 14-16) were filled in with fresh sowings. The latter is well stocked now. The 'tin planting' method of South Africa was also tried here. Kerosene tins were cut in halves and these were filled with proper media placed on a platform, and *chir* grown in them. The plants were shaded and watered with a fine rose. When seedlings were sufficiently big the tins were taken to the planting site and planting done direct or with cakes of earth. The results so far are encouraging, giving 97 per cent. survivals at the end of the year.

A C-grade thinning was done in some of the earliest plantations and a mechanical thinning with a 6' stick-gauge was tried in one of these compartments, resulting in a fairly even espacement of 9'×9' on the average. A number of compartments are under thinning research experiments in this circle.

II. Statistical Section.

(i) YIELD TABLES.

The total number of sample plot files maintained during the year is 1656, which shows an increase of 119 plots over last year's figures. Out of these, 19 sample plots were received from Hyderabad division (Sind) and the rest were shared by all other provinces, including Kashmir State.

Out of a total number of 309 sample plot files received for routine computations from different provinces only 240 were computed during the year.

Sapwood measurements were taken on 474 deodar trees in Lower Bashahr division. The results have been computed and written up for publication. Five deodar sample plots in Simla (now Lower Bashahr) division were remeasured and computed and 17 comparative thinning sample plots in *Shorea robusta* crops were laid out by the Forest Research Institute in Dehra Dun division.

Some sapwood data of sal were received from the United Provinces and analysed but the results were not found suitable for publication.

Two statistical field parties were sent to the Terai and Bhabar Estate division for collecting the khair (*Acacia catechu*) data on stump and stem analyses, and the computation has been completed.

(ii) MISCELLANEOUS.

A note on the Formation of heartwood in Deodar was prepared by the Statistical Assistant Silviculturist and submitted for publication. Some tests on the precision of the standard sample plot method of determining basal area, height and volume per acre by means of sample trees were made by measuring up clear-felled plots. The results were published in the *Indian Forester* of January 1937, and showed that the standard method gives results that are generally accurate within ± 5 per cent. if reasonable care is taken in the selection of sample trees.

III. Miscellaneous.

(i) PUBLICATIONS.

A Manual of Indian Silviculture, Part I, was written by Mr. H. G. Champion and is now in the press.

(ii) PHOTOGRAPHIC SECTION.

Due to the ever increasing demand for photos and slides, etc., by the provinces including exhibition authorities, and to changes of photographers who have been always in the temporary establishment, heavy arrears of work have accumulated in the photo section, although every effort is being made to reduce arrears as much as possible with the present limited staff.

The routine work carried out compares with previous years as follows :—

Year.	Negatives made.	Prints made.	Lantern slides made.	Colour Photos.
1933-34	1,093	2,271	400	..
1934-35	932	3,420	130	18
1935-36	748	2,791	301	6
1936-37	916	4,213	103	27

Of the new negatives 28 were the photos taken by Mr. Champion in Almora, etc., and 130 were photos taken by the Silviculturist during his tours, in Bengal, the Punjab and the Central Provinces.

398 photos were taken in the Timber Testing Section and 251 were taken for different Branches and Sections of the Institute.

89 negatives from the Silviculturist, U. P., and two negatives from Mr. Pring, Punjab, were received and added to the collection.

The total number of prints in the general series comes to 3,798 and in the specific series 4,529, against 3,529 and 4,341 respectively for the last year.

1,278 prints were prepared for different provinces and states and 164 were made for reproduction in various publications.

66 lantern slides were prepared and added to the Forest Research Institute collection.

17 Stereo photographs were added during the year bringing the total up to 108.

(iii) RECORDS.

Large arrears have been cleared off this year by appointing a temporary extra typist in the ledger section. All English periodicals have been ledgered up to date, but the foreign periodicals are still 6 months in arrears. Much of the ledgering has been done by titles only, due to the lack of time and staff.

Abstracts of all Indian forest literature were prepared as usual for five agencies in India and abroad.

45 new books and working plans were added to the library during the year bringing the total to 719 with 546 bound volumes of periodicals. A list of additions with brief abstracts was circulated to provinces as usual.

There are 1,277 specific and 470 general ledger files out of which 42 new specific and 24 new general files were added to the collection during the year under report.

(iv) WORKING PLANS.

Notes were written on the Jhansi, Damoh (Central Provinces) and Northern Shan States plans and the suggestions made thereon have been generally adopted in the plans.

(v) MUSEUM.

Progress in the Museum was limited owing to the absence of the Museum Artist for two long periods, namely for about one month when his services were lent to the Punjab for preparing an erosion model for agricultural shows and for four months when he erected and demonstrated a model to illustrate erosion of denuded areas by rainfall at the Lucknow Industrial and Agricultural Exhibition. The erosion model in the Silvicultural Museum at the Forest Research Institute was dismantled for this purpose, but a duplicate travelling model is now being made.

The model to illustrate the influence of local climate on vegetation, the phenomena of altitudinal zonation, succession and retrogression, and the effects of site and soil is about half finished. Some improvements have also been made to the earlier models.

(vi) STAFF.

Mr. H. G. Champion, the late Silviculturist, toured in Kumaon and Chakrata during the hot weather of 1936. He reverted to his province and was succeeded by Mr. M. V. Laurie on the 6th October 1936. Mr. Laurie was on tour in Bengal, the Central Provinces and the Punjab during the year.

The President wishes to record his appreciation of Mr. Champion's services to Indian silviculture during his long service at the Institute.

(vii) VISITING FOREST OFFICERS.

According to the scheme for a Research Demonstration course several forest officers visited the branch to discuss their local silvicultural problems and research methods. Among them were Mr. K. P. Sagreiya, Silviculturist, C. P., Mr. J. D. Mahendru, Assistant Silviculturist, Punjab, Mr. C. W. Kermode, Silviculturist, Burma, Messrs. Sant Ram and Jalmeja Singh Majithia from the Punjab, Mr. S. S. Negi and Mr. Ford-Robertson from the United Provinces.

Mr. E. J. Strugnell from the Forest Research Institute, Kuala Lumpur, Malaya, also visited the Institute in the course of a tour in India arranged for him by the Silviculturist.

CHAPTER III.—BOTANY BRANCH.

Systematic Botany.

The systematic study of the Indian *Terminalias* of the section *Pentaptera* was completed and submitted for publication in Indian Forest Records. This section comprises trees of economic importance and an attempt has been made to understand the species of the older authors and to clear up some misunderstanding in this difficult group in which four species with three varieties and nine forms are recognised. A note on their botanical history with keys to the species, varieties and forms and descriptions of them and their distribution and occurrence as represented by herbarium collections is given.

A paper dealing with the following five species of the family *Dipterocarpaceae* was completed and submitted for publication also in Indian Forest Records: *Hopea helferi* (Dyer) Brandis, *Hopea oblongifolia* Dyer, *Shorea floribunda* (Wall.) Kurz, *Shorea assamica* Dyer and *Shorea sciceiflora* Fisch. & Hutch. These trees, which are of some economic importance, are illustrated and described, in some cases completely for the first time, and notes regarding their distribution, occurrence and field characters are given.

A paper on a new genus of *Connaraceae*, *Schellenbergia*, from Burma and one on three species of Indian *Terminalias*, covering the two confused species *T. citappa* Linn. and *T. procera* Roxb. and the little-known species *T. burmanica* King from Upper Burma was published in the *Indian Forester*.

The second part of "Recently introduced or otherwise imperfectly known plants from the Upper Gangetic Plain" by Mr. Mukat Behari Raizada was published in the *Journal of the Indian Botanical Society*, Vol. XV (1936), pp. 149-167. The object of these papers, which are in the nature of supplements, is to make any amendments that may appear necessary and to put on record changes that may be noticed in the flora from time to time so as to keep it as up-to-date as possible for the convenience of those that use the flora and to facilitate revision.

In collaboration with the Chemistry Branch of this Research Institute, Part I of the Minor Forest Products of the Chakrata, Dehra Dun, Saharanpur and neighbouring Forest Divisions, The Oil Bearing Seeds, was published during the year. The second part, dealing with Drug yielding plants, was taken up and considerable progress made.

A paper on Indian Plants reputed as Fish Poisons was submitted for publication in the *Indian Forester* by Mr. Mukat Behari Raizada in collaboration with Mr. B. S. Varma of the Chemical Branch of this Institute. The object of this paper is to furnish information regarding Indian plants likely to yield efficient insecticides the demand for which has greatly increased during recent years.

The question of the conservation of certain botanical specific names of plants of economic importance has recently been taken up. At the instance of Prof. R. S. Troup, Director of the Imperial Forestry Institute, Oxford, supported by five Forestry Societies and Institutions in Great Britain, by the Inspector General of Forests, India, on behalf of the Forest Research Institute, Dehra Dun, and the Forest Department in India, and by the National Institute of Sciences of India, a motion to make provision for such conservation in the International Rules of Botanical Nomenclature was submitted for consideration by the Sixth International Botanical Congress that met in Amsterdam in 1935. The principle of such conservation was not accepted by the Congress but a compromise was effected by the appointment of an International Committee to draw up a list of the names of economic plants affected or likely to be affected by change, to be stabilised for ten years. It is thought that a list which is stabilised for ten years will probably remain in permanent use. A list of well-established names of Indian trees of forest importance for which changes have been recently made or proposed was drawn up and submitted to Dr. Burtt Davy of the Imperial Forestry Institute to be placed before the Committee for consideration.

A certain amount of work was done in connection with the collection of botanical material and the study of the two South Indian species of *Dipterocarpus*, *D. indicus* Bedd., and *D. bourdillonii* Brandis, and in the preparation of a note on the field characters of some Indian and Burmese bamboos.

Identification of specimens.—In addition to the 670 plant specimens identified for Forest Officers and others in India, about 600 specimens, collected by the Forest Botanist and his assistant during their tours in the Chakrata forest division, were also examined and determined for incorporation in the herbarium and distribution to other herbaria, bringing the total up to 1,270; this number falls short of that of the previous year owing to the absence of the Forest Botanist on leave for four months during which time the work of identification was done by only one assistant who has numerous other duties to attend to; a number of specimens have therefore been left over to be identified during the ensuing year. As has been mentioned in the previous year's report the identification of specimens received from Forest Officers and others in India is done in the nature of routine work and as, in many cases, this is of a critical nature it cannot be hurried and takes up a great deal of the time of the Forest Botanist and his assistant.

Among the most notable collections received for identification are those sent in by Messrs. H. F. Mooney; J. S. Owden, Conservator of Forests, Bihar; V. S. Rao, Deputy Conservator of Forests, Bengal; and J. N. Sen Gupta, Assistant, Silvicultural Branch, who brought with him a collection of plant specimens from the Andaman islands.

Herbarium.—The number of specimens incorporated during the year amounted to 2,586; during the last eight years, including the year under review, 25,479 specimens have been added to the herbarium which, with the number estimated to be in the herbarium on the 1st January 1929, i.e., 220,000, now brings the total to near the quarter of a million mark. Of the additions made during the year the following were obtained from other herbaria or botanical institutions by exchange or donation :—

Naturhistoriska Riksmuseet, Botaniska Avdelningen, Stockholm, Sweden	476
Imperial Forestry Institute Herbarium, Oxford	247
National Herbarium, Pretoria, South Africa	120
Mr. Geo. L. Fisher, Houston, Texas, U. S. A.	125
Gray Herbarium, Harvard University, Cambridge, Mass., U. S. A.	100
Mrs. Agnes Chase, Bureau of Plant Industry, Smithsonian Institution, Washington, U. S. A.	80
Director of the Herbarium, Botanical Garden, Buitenzorg, Java	2
Royal Botanic Garden, Calcutta	97
TOTAL	1,929

The principal other additions are from the collections made by the Forest Botanist and his assistant, chiefly from the Chakrata hills, from Mr. H. G. Champion, I.F.S., 153 specimens from Almora, Haldwani and Dehra Dun, and Mr. R. N. Parker, I.F.S., 38 Punjab specimens. The remainder is made up from the numerous smaller collections and individual specimens sent in by Forest Officers and others from the various provinces for identification.

The following specimens were distributed to other herbaria as donations or on an exchange basis :—

The Director, Royal Botanic Garden, Edinburgh	182
Der Direktor, Botanischer Garten und Museum, Berlin-Dahlem, Germany.	148
The Forest Botanist, Maymyo Herbarium, Burma	130
Mr. Geo. L. Fisher, Houston, Texas, U. S. A.	125
TOTAL	585

Suites of herbarium specimens were sent to the following specialists, for study in connection with the preparation of monographs or other publications with the result that several species new to science have been recognised and their descriptions, based on this material, will shortly be published; this incidentally greatly enhances the value of our material for further systematic study.

1. A selection of 66 sheets of *Ixora* from Burma and the Andaman islands to Dr. C. E. Bremekamp of the Herbarium and Botanical Museum

of the University of Utrecht. Dr. Bremekamp has from his study of this material raised the number of species of *Ixora* known to occur in Burma from 17 to 35 and in the Andamans from 3 to 7.

2. Eighteen sheets of *Tsuga* to Mons. H. Gaußen of the Laboratoire Forestier de Toulouse.

3. A hundred and eleven sheets belonging to the allied genera *Hydnocarpus*, *Taralogenos*, *Asteriastigma* and *Gynocardia* to Dr. H. Sleumer of the Botanical Garden and Museum, Dahlem, Berlin.

4. The herbarium material of the genus *Impatiens* numbering nearly 800 sheets to the Director, Botanical Garden and Museum, Dahlem, Berlin.

The re-arrangement of the foreign (non-Indian) collections was continued throughout the year by the Herbarium clerk and progress was made from the *Podostemonaceae* to the *Gramineae* so that the arrangement is now nearly complete.

A series of portrait photographs of botanists who have been connected with the study of Indian Botany has been started; these portraits are hung in the Herbarium to which they form an interesting addition.

Library.—Seventy-eight books and seventy-six volumes of periodicals were added to the library during the year. A notable addition among these is the complete set up to date of 25 volumes et Additamenta 1-4 of the well-known and indispensable standard work on fungi, Saccardo's *Sylloge Fungorum*. The work of card-indexing items of systematic and other importance from the literature in the library was continued but could not be completed owing to pressure of other work.

Tours.—The Forest Botanist toured for about four weeks during the month of June in the Chakrata division during which the inoculation experiments that were being conducted by the Mycologist in connection with his biological studies of the coniferous rusts were seen and a collection of herbarium specimens made in quadruplicate for the Research Institute herbarium and for purposes of exchange with other herbaria. Mr. Mukat Behari Raizada, Lower Assistant, made a two weeks tour in the Chakrata hills during the month of September and brought in an interesting collection of nearly 300 specimens of autumn-flowering plants for our herbarium and for exchange; most of our collections from this area were made during the Spring and early Summer and this Autumn collection is a welcome addition to the herbarium.

The Mycologist toured in the Chakrata division during the months of May to July and September to October in connection with his investigations of the biology of the Himalayan coniferous rusts and the finding of their alternate hosts; during these tours a collection of specimens of fungi was also made for the mycological collection at the Research Institute.

Mr. Mukat Behari Raizada visited the All-India Ayurvedic Conference and Exhibition at Gurukul-Hardwar in March at the invitation of the Organising Secretary and exhibited a representative collection of about 250 Indian medicinal plant specimens in addition to other interesting exhibits from the Forest Research Institute; considerable interest was taken in these exhibits by those interested in obtaining genuine and unadulterated samples of Indian drugs.

Seed supply.—The list of seed offered on an exchange basis from plants grown in the Arboretum and Botanical Garden was, as in the previous year, distributed to the Provincial Forest Departments in India and, as usual, to various botanical institutions in India and abroad with which seed exchange relations are maintained. About 560 packets of seeds were supplied in response to the numerous requests received for the seed offered in the list the distribution of which has greatly increased the demand and it is with considerable difficulty that even a portion of the numerous requests can be complied with on account of our small staff. In addition to this about 35 larger indents for seed, aggregating nearly 4,600 pounds, were supplied. The seed mostly in demand being *Pinus longifolia* and *Pinus khasya* for the South African Forest Department, *Pinus khasya* for Sumatra, teak and *Eugenias* for the Agricultural Department, Zanzibar, *Acacia arabica* for Java, *Platanus orientalis* for China, *Cedrus deodara* for Japan and *Sageraea listeri* and *Pinus caribaea* for trial in Indian provinces. Seeds of *Bambusa polymorpha*, *Phoebe hainesiana* and *Acacia arabica* and of various Indian trees were also obtained for the Central Silviculturist, Forest Research Institute, for his seedling studies.

Botanical Garden and Arboretum.—Work in the Botanical Garden and Arboretum continued to make good progress. The Botanical Garden is shaping well and attracts many visitors especially in the Spring and Autumn when the winter and rainy season annuals, which have been very successfully grown, are in flower. The lily garden has also been an attractive feature of the garden. The greenhouse and glasshouse were moved from the old Fruticetum and erected in the Botanical Garden and although completed rather late in the season the glasshouse has already been planted up with various interesting Cacti and Xerophytic plants and is already an interesting addition to the garden, while work on the planting up of suitable creepers for covering the frame-work of the greenhouse has already been done and good growth is expected during the coming rainy season. The rose garden was re-arranged and several new roses added to the collection. About 120 plants, representing 20 families and 34 genera, were planted out in the botanical garden and about 15 acres of lawn maintained. The brick lining of the feeder channels and the use of a series of galvanised iron troughs has proved both rapid and economical in irrigation

arrangements. A new tank of 1,296 cubic feet capacity was built near the south eastern corner of the garden.

In the experimental garden and nursery about 350 plants were raised for planting out in the Arboretum, Botanical Garden, in avenues and elsewhere and in addition a large number were also raised and distributed for planting in the residential grounds at New Forest in the adjoining Indian Military Academy and elsewhere.

The Arboretum is also being steadily added to nearly 100 plants representing 12 families and 15 genera having been planted out during the year. Two new avenues of quick-growing species, *Ailanthus glandulosa* and *Sapium sebiferum*, were planted out on the west side of the main building. Little or no damage was done by frost during the year as the winter was a comparatively mild one.

The following plants were recorded during the year to have flowered for the first time at New Forest:—*Sophora riciifolia* Hance, *Melia composita* Willd., *Sapium eugeniaefolium* Ham., *Amorpha glabra* Poir, *Anona cherimolia* Linn., *Xylia dolabriformis* Benth., *Alseodaphne keenanii* Gamble, *Pentstemon bradburyi* Pursh., *Catesbea spinosa* Linn., *Stigmaphyllon puberum* A. Juss., *Spathodea campanulata* Beauv., *Zizyphus incurva* Roxb., *Dysoxylum binectariferum* Hk. f., *Cassia marginata* Roxb., *Cordia abyssinica* R. Br.

Miscellaneous.—As usual many enquiries on botanical subject received from Forest Officers and others in India were answered and advice given in botanical matters.

The death of Pt. Jagar Mani, Field Assistant, on the 4th January 1937 at his home in Garhwal, when on leave, is recorded with regret. Jagar Mani served in the Botanical Branch of this Institute for 29 years and accompanied several officers of this Branch on tours in India and Burma and made an independent collection in the Naga hills.

Mycology.

Sal root disease due to Polyporus shoreae and other associated problems.
—A large number of specimens of sal root rot from Bihar and Orissa were examined and a collection of sporophores of various types of *Polyporaceae* was made from the infected area, the chief ones among them being *Polyporus shoreae*, *Fomes tricolor* and *F. fastuosus*. Pure cultures of the two first-named fungi have been obtained and the cultural characters are being studied.

It is proposed to conduct a field study in the infected area as this has a bearing on the various diseases of sal and on the mycorrhizal problems the study of which was taken up during the year.

Mycorrhizal fungi and associated problems.—This investigation has been taken up recently. The examination of the roots of a number of local forest trees has revealed the presence of mycorrhizal fungi, and definite fungal mantles on the rootlets of sal and *Quercus incana* were found. Other forest trees will be examined for mycorrhizal fungi as time permits.

A critical histological examination of the material available was conducted.

Die-back disease of Gmelina arborea.—This has been kept in abeyance till the Peridermium investigation has been completed.

Damping off disease of the forest tree seedlings.—To be held in abeyance till the completion of the Peridermium investigation.

Cultural studies of wood-rotting fungi and their pathogenicity.—The cultures of a large number of fungi were maintained and data on the wood-rotting properties of several tropical *Polyporaceae* were recorded. It is now proposed to use these cultures for the toxicity tests of various wood preservatives and a beginning has been made with *Asci*.

Cultural studies of some fungi attacking coniferous trees and their pathogenicity.—The inoculations on *Pinus excelsa* and *Cedrus deodara* with *Trametes pini* and *Fomes annosus* respectively showed signs of infection while those inoculated with *Armillaria mellea* remained abortive.

Cultures of various temperate wood-rotting fungi were maintained for study and sent abroad to other institutions.

Biology of various coniferous rusts and experiments to find out their alternate hosts.—

(a) *Peridermium himalayense* on *Pinus longifolia* and *Cronartium himalayense* on *Swerzia* spp.—The third part of this work dealing with the results of inoculations on pine is almost complete. No further work is contemplated in this connection.

(b) *Peridermium indicum* on *Pinus excelsa* and *Cronartium* sp. on *Ribes rubrum*.—A draft paper on the biology of this rust was prepared and the necessary figures have been completed.

The biology of the following needle rusts of conifers have been worked out and the results were confirmed by repeating the experiments the second year :—

(c) *Peridermium orientale* (*P. complanatum*) on *Pinus longifolia* with *Coleosporium campanulae* on *Campanula colorata* and *C. canescens*.

(d) *Peridermium brevius* on *Pinus excelsa* with *Coleosporium* nov. sp. on *senecio rufinervis*.

- (e) *Peridermium piceae* on *Picea morinda* with *Chrysomyxa himalayensis* on *Rhododendron arboreum*.
- (f) *Peridermium ephedrae* on *Ephedra vulgaris* with *Hyalopsora* nov. sp. on *Athyrium acrosticoides*.
- (g) *Peridermium abies-pindroina* nov. sp. with *Uredinopsis* nov. sp. on *Polypodium* sp.

The following needle rusts of conifers yet remain to be worked out though more than 300 inoculations were conducted during the last two years in an endeavour to match them:—

- (h) *Peridermium cedri* on *Cedrus deodara*.—Tests in connection with the probable alternate hosts, both broad-leaved and ferns, exceeded two dozen in number. There are still several broad-leaved species which appear likely hosts and on which inoculations will be made this summer.
- (i) *Peridermium thomsoni* on *Picea morinda*.
- (j) *Chrysomyxa deformans* on *Picea morinda*.
- (k) *Chrysomyxa piceae* on *Picea morinda*.

Histological studies on the parasitism of the above 4 species were made and the sequence of their appearance from early spring to autumn recorded.

- (l) *Chrysomyxa dietelli* on *Rhododendron lepidotum*.—Further observations are being continued.

Routine problems.—(a) The inoculations on *Dalbergia latifolia* with cultures of a canker fungus have repeatedly failed. Further observations and search for fruit-bodies of the fungus will be made during the rainy season.

(b) *Herbarium*.—A large collection of larger fungi including several species of *Armillaria* and many of *Polyporaceae* has been made. Arrangements were entered into for their naming to build up a well-represented herbarium.

The collection of Himalayan *Uredinales* appears to be almost complete. It consists of a number of new species of *Coleosporiums*, *Phakopsora*, *Uredinopsis*, *Hyalopsora* and several fern rusts which do not appear to have been recorded before.

The collection work will be continued and special notes will be made of the *Agaricaceae* found in the region of *Pinus excelsa* and *Cedrus deodara* for mycorrhizal studies.

A photographic collection of fungi was started for future reference.

CHAPTER IV.—FOREST ENTOMOLOGY.

BIOLOGICAL CONTROL.

Several species of parasites of defoliators have been studied with a view to the possibility of their introduction to new localities and to their multiplication under artificial conditions. Of these particular attention has been given to *Cedria paradoxa*, a Braconid which parasitises many species of Pyralid caterpillars, including *Hapalia machaeralis*, one of the two most important teak defoliators and *Margaronia pyloalis*, the mulberry defoliator. This parasite can now be reared in large numbers under laboratory conditions and consignments are being sent to Madras and Burma for the teak defoliator and to the Punjab for the mulberry defoliator. Difficulties arising from the necessity for sending living insects over long distances can be overcome by the use of cold storage; an experimental consignment, consisting of cocoons packed with ice in a vacuum flask, was successfully sent from Dehra to Burma by air.

CARDAMOM INSECTS.

At the request of the Chief Forest Officer, Coorg, some of the cardamom males in Coorg were inspected during September and October 1936. Numerous types of insect damage were observed but these are not all of universal occurrence. The damage is due to a variety of causes which vary from place to place. There is no evidence of a specific cardamom pest, the insects concerned being derived from neighbouring forest trees. Recommendations were made which should lead to reduction of insect damage.

SPIKE DISEASE OF SANDAL.

Reports on seasonal incidence and distribution of four more groups of insects have been prepared for the press. In this work 7,700 specimens were identified and 170 species were added to the known insect fauna associated with sandal.

Since 1933 the work initiated by this Institute has been continued by the Madras Forest Department. In September 1936, the Forest Entomologist, at the request of the Chief Conservator, Madras, attended a meeting at Denkanikota to give his opinion on current investigations and to advise in the drawing up of a programme for future work.

The Institute has identified a large number of specimens of the species under observation by the Madras Forest Department.

LANTANA INSECTS.

The lantana fruit fly, *Ophiomyia lantanae*, is now known to be widespread in India but does not appear to provide the solution for lantana

control ; it has some beneficial effect in making a proportion of the fruits shrivel and therefore unpalatable to birds which normally spread the seed. There is some doubt as to how far attack by the fly affects the viability of the seed and experiments devised to clear up this point are in progress. At present it is not proposed to introduce into India other lantana-attacking insects until results of work in progress in Australia and elsewhere are known ; in the meantime the possibilities of artificial multiplication of certain indigenous species of insects are being investigated.

BORERS OF *QUERCUS INCANA*.

The Sitoli plantation in West Almora division was visited in June. The oak trees here, which are used for firewood, were found to be attacked by larvae of two large species of Cerambycidae, *Aphrodisium hardwickianum*, the habits of which were previously unknown and *Batocera horsfieldi* which was known to cause serious damage to walnut as well as to oak. A large proportion of the wood content of the tree is lost by repeated attack, the damage now observable being the accumulation of many years' boring. The suggested remedy is to coppice the plantation or at least those trees showing ejection of wood dust, in early spring.

GENERAL INSECTARY WORK.

During the year 149 consignments were received from forest divisions in India. 39,000 insects emerged from cages containing attacked material collected by forest officers or by the entomological staff ; most of these insects were identified. In addition, numerous lepidopterous defoliators were reared in connection with biologic studies of these species and their parasites.

TRAINING.

A course in forest entomology, consisting of 18 lectures with demonstrations, was given to the Rangers Class by Mr. N. C. Chatterjee, Assistant Entomologist.

Mr. P. N. Chatterjee, a student of Allahabad University, worked in the parasite laboratory of this branch for 2½ months in connection with the preparation of his thesis for the M.Sc. degree.

A sleeper-passing officer of the Indian State Railways was given instruction in elementary entomology with special reference to the detection and classification of damage by borers of sal timber.

Systematic Entomology.

The reference collection has been enriched by 702 species, many of which are new to science and have been described in Indian Forest

Records and other scientific publications. As in former years assistance has been given by specialists in various parts of the world but difficulty is still found in obtaining authoritative identification in certain families including some of the parasitic groups so important in biological control.

Considerable headway has been made in the classification of immature stages of Coleoptera and several papers on the subject have been published. Similar work is in progress on lepidopterous larvae of forest importance ; the larvae of very few Indian species have been previously described in sufficient detail to enable reasonably accurate identification.

Tours.—By Dr. Beeson to Madras in September ; to Ranchi in October (Lac Cess Committee) ; to Lucknow in November (Industries Conference) ; to Burma in February (in connection with entomological research in Burma). By Mr. Gardner to Simla hills in July ; to Mussoorie in September ; to New Delhi in November and March. By Mr. N. C. Chatterjee to Madras in September ; to Haldwani in December. By Mr. B. M. Bhatia to Almora in June. By Mr. S. N. Chatterjee to Burma in February.

Museums.—The chief additions to the entomological museum were 81 examples of damage to timbers by borers. Reptiles were added to the museum of forest zoology.

Library.—164 books, besides periodicals, were added to the Zoological Library during the year.

CHAPTER V.—UTILISATION BRANCH.

Wood Technology Section.

1. RESEARCH.

(a) Work in connection with the preparation of hand lens keys supplemented with low power photomicrographs for the identification of the more important commercial timbers of Assam and Bengal was continued.

(b) Studies on the formation of growth rings in the wood of *Acacia catechu*, *Bombax malabaricum*, *Eugenia jambolana*, *Pinus longifolia*, *Shorea robusta*, *Tectona grandis* and *Terminalia tomentosa* were completed. The results obtained indicated the advisability of studying some more species of certain characteristic anatomical structure. During the period under review, the collection of data was started for *Albizzia lebbek*, *Cedrela toona*, *Dalbergia sissoo*, *Michelia champaca* and *Swietenia mahagoni*.

Last year a new type of parenchyma distribution was reported in *Terminalia tomentosa*. During the year further research has been done on this subject with a view to tracing the origin of this distribution. The results so far obtained have been very interesting and the whole problem will be fully discussed in a future paper.

(c) The anatomical study of the woods of Indian Dipterocarps was continued. The macroscopical and microscopical examination of the wood blocks and slides is progressing.

(d) The work on the anatomical study of different varieties of *Terminalia tomentosa* was also continued. This investigation has proved to be very complicated and further research will be necessary before any definite conclusion can be drawn.

(e) Due to lack of material, further study on the relationship between the anatomical structure and the physical properties of *Tectona grandis* was not possible during the period under review. Fresh material (selected according to our suggestion) has now been received and the work will be restarted.

(f) The study on the woods of Indian *Meliaceae* is progressing satisfactorily. More specimens have been cut and mounted during the year.

2. IDENTIFICATION OF WOODS.

As usual large numbers of timber specimens were received from various sources. These included a wide range of materials including solid timbers, veneers, plywood, match splints, pencils, etc. The total number of timbers identified during the year was about 350.

3. EXAMINATION FOR DETECTING FUNGUS ATTACK.

Many enquirers sent samples of wood suspected of having been attacked by fungus and asked advice as to the suitability of such timbers for certain specific uses. A good many investigations of this type were carried out for the aircraft authorities in India. The number of wood specimens examined in this connection was 66.

4. SPECIAL ENQUIRIES.

Several special problems were taken up on behalf of research officers of the Institute and forest officers in the provinces. Work was also done for many business firms. Enquiries received under this heading were, as usual, of a very varied nature—each one requiring special technique and manipulation and taking considerable time to complete. The following is an example of an interesting investigation dealt with during the year :—

A firm in Colombo, Ceylon, sent two samples of wood and wanted to know whether they were both teak and if so, the reason for their difference in weight and working qualities. On examination the timbers were both found to be teak. One sample showed normal growth and was of normal weight, while the other showed extremely slow growth. The latter had over 35 rings per inch and the wood mostly consisted of large pores of early wood, leaving very little space for fibres which are usually responsible for strength as well as weight. In this connection, it may be mentioned here that the question of growth rings in relation to the technical properties of wood is being investigated at the Forest Research Institute and it is hoped in time to collect workable data for all important Indian timbers.

5. INDEXING PERMANENT SLIDES, ANATOMICAL DATA AND PHOTOMICROGRAPHS.

During the year under review over 600 permanent slides were prepared and added to the authentic collection. These included a large number of species (both Indian and foreign) not previously represented. Anatomical data were also collected from these slides whenever possible and filed for future reference. For publication and exhibition purposes 50 negatives, 400 photomicrographs, 14 enlargements and 8 transparencies were made.

6. COLLECTION OF AUTHENTIC WOOD SPECIMENS.

(a) *From India.*—A fairly large number of authentic wood specimens backed by herbarium material were received from the different provinces for the Institute's standard collection.

(b) *From abroad*.—During the year altogether 129 wood specimens were added to the foreign collection. These were received from England, Nigeria, the Philippine Islands, and the United States of America. To the donors our sincere thanks are due for helping the Forest Research Institute to make its collection of commercial timbers of the world as complete as possible.

7. DISTRIBUTION OF WOOD SPECIMENS.

In response to requests from abroad and various parts of India, 898 samples of timber were supplied to interested enquirers.

8. GENERAL.

A short course in Wood Technology was given to Mr. A. Ghaffar, Student Sleeper Passing Officer, B. N. Railway, Calcutta. Mr. Jagdish Prasad, Assistant Engineer, United Provinces, was also under training in the Section for a short time with a view to obtaining some knowledge of wood anatomy from the point of view of an engineer.

Timber Testing Section.

SPECIAL INVESTIGATIONS.

1. The study of the effect of corrosive chemicals on wood (*vide* para 9 page, 44), was continued during the year under review. Small sticks of teak (*Tectona grandis*), deodar (*Cedrus deodara*), chir (*Pinus longifolia*), kail (*Pinus excelsa*), sissoo (*Dulbergia sissoo*), and sal (*Shorea robusta*) were immersed in different strengths of sulphuric acid and caustic soda, with controls in water, for different periods. The preliminary tests have been finished and these show a very large reduction in the compressive strength of the timbers as the result of soaking in higher concentrations of caustic soda. The strength of the pieces soaked in sulphuric acid, however, did not show much reduction. The investigation is being continued.

2. Yon (*Anogeissus acuminata*) was suggested by the Forest Research Institute as a possible substitute for ash for making skis. This enquiry was received from the Timber Adviser to the High Commissioner for India in London. The suggestion of a possible substitute created much interest among the manufacturers of skis in England and the Timber Adviser has requested the Burma Forest Department to supply some timber for trial. The results of this trial will be awaited with interest.

3. An enquiry was received from the Linen Industry Research Association, North Ireland, through the High Commissioner for India, London, for a suitable substitute for boxwood (*Buxus sempervirens*) for making spinning rollers. All the boxwood now used is imported

into England from Persia, Arabia and Africa and it sells at a very high price. The boxwood available in India is at present unfortunately insufficient even for the internal demand. The following species, namely chooi (*Sageraea elliptica*), kow (*Olea ferruginea*), parrotia (*Parrotia jacquemontiana*), *Gardenia latifolia*, *Gardenia lucida* and *Murraya exotica* were suggested for trial and specimens were sent to the Director for his opinion. This investigation if successful may open up a market for one or more of the above species. Good prices would be paid for a suitable wood.

4. Wood used in aircraft construction and samples obtained from wooden parts damaged in accidents were tested from time to time for the Director of Civil Aviation.

5. Fifteen consignments of glue joints submitted by Ground Engineers of the different Flying Clubs of India for their licence examination were examined and reported on to the Director of Civil Aviation. The Officer in Charge of the Timber Testing Section designed an improved type of end grip for holding efficiently these test specimens in the testing machine. The improved grip is constructed so as to eliminate all bending stresses on the joint and to apply a direct pull in the plane of the joint.

6. A special investigation has been started with a view to introducing Indian timbers into aircraft construction. Practically all aeroplane spruce is now obtained from Canada or the United States of America. Indian spruce and fir, *Michelia excelsa*, *Polyalthia fragrans* and *Phoebe* spp., are under investigation for this purpose. The Officer in Charge, Timber Testing Section, discussed the requirements of timber used in aeroplanes with the Director of Civil Aviation and explained, with the aid of small specimens, the strength data of the above species. He also visited with the Inspector of Aircraft, the civil aerodrome at Delhi where considerable repair work was going on. There he found that actually about 75 per cent. of the spruce used was under 10 ft. in length. As the only spruce available in India is in sleeper form and as these sleepers are usually 10 to 12 ft. long, it has been explained to the aircraft authorities that Indian spruce might be used for 75 per cent. of the aircraft wood work as it is equally as strong as Canadian spruce. As, however, it is necessary to satisfy the designers and manufacturers in England about the suitability of Indian spruce before it can be introduced into the specifications, steps are being taken to send samples to the manufacturers through the Director of Civil Aviation for test. Very high prices are paid for aircraft spruce, and this investigation might eventually provide a profitable market for selected Punjab spruce.

7. In order to see whether any improvements were required in the grading rules for teak squares, some discussions were held with the Forest Economist, Burma, at the time of his visit to the Forest Research

Institute. It was decided that the Officer in Charge, Timber Testing Section, should re-examine in India some consignments of teak passed in Burma under the new rules. A thorough examination of 2,000 tons of Burma teak now arriving at the North Western Railway workshops at Lahore is in hand.

8. Great efforts were made during the year to popularise Indian timbers and to increase their utilisation. The Timber Testing Section's share in this work was the preparation of strength charts and tool handle posters, both of which proved very popular. The first issue was sold out in a short time.

9. The testing of poles of different Indian species was started during the year as a result of numerous enquiries received on this subject. Treated wooden poles are now being used for telegraph, telephone and power lines, and reliable strength data are necessary for preparing specifications for different requirements. The investigation will be continued.

10. At the Utilization Conference in March 1937, the Officer in Charge discussed the relation of rate of growth to strength. He also explained the relative merits of sapwood and heartwood from the strength point of view.

ROUTINE TESTING.

During the year under report tests were continued under Project 1 (Standard tests on small clear specimens) and Project 2 (Standard test on structural timbers). Other routine testing such as glue adhesion, plywood, hammer handles, etc., was also done whenever enquiries were received.

NUMBER OF SPECIES TESTED DURING THE YEAR.

	Green.	Air dry.	Kiln dry.	Miscellaneous.
Project No. 1	.	.	15	7
Project No. 2	.	.	1	7
Project No. 0	.	.	Under all heads	..

The 67 consignments under Project 0, include 15 consignments of glue joints submitted by Ground Engineers for their licence examination.

NUMBER OF SPECIES COMPUTED DURING THE YEAR.

	Green.	Air dry.	Kiln dry.	Miscellaneous.
Project No. 1	.	.	15	4
Project No. 2	3
Project No. 0	.	.	Under all heads	..

List of species tested under Project No. 1 during the year.

Species.	From	Condition.
<i>Amoora rohituka</i> (amoora)	Nowrang Div. (Assam)	Air dry.
<i>Amoora walliepii</i> (amoora)	Katha Div. (Burma)	Klin dry.
<i>Artocarpus integrifolia</i> (kos)	South Western Div., Colombo (Ceylon)	Green.
<i>Baeria bulgarica</i> (hill molwa)	South Andaman	Green and Klin dry.
<i>Cinnamomum iners</i> (cinnamon wood).	Tavoy Div. (Burma)	Air dry.
<i>Engelhardtia spicata</i> (moglajpoma)	Cachar Div. (Assam)	Green.
<i>Eucalyptus eugenioides</i>	Nilgiri Div. (Madras)	Air dry.
<i>Eugenia</i> spp. (Jwanan)	Cachar Div. (Assam)	Green.
<i>Heterophragma roxburghii</i>	Nagpur Div. (C. P.)	Green
<i>Kaya floribunda</i> (karai)	Cachar Div. (Assam)	Air dry
<i>Mimusops litoralis</i> (bullet wood)	South Andaman	Green and Klin dry.
<i>Myristica</i> spp. (minalaboda)	South Western Div. Colombo, (Ceylon)	Green.
<i>Pentace griffithii</i> (bilisko)	Lakhimpur Div. (Assam)	Green and Klin dry.
<i>Poeciloneuron indicum</i>	N. Mangalore Div. (Madras)	Green
<i>Pongamia glabra</i> (sv. karanjli)	E. D. Kanara (Bombay)	Green and Klin dry.
<i>Pterocarpus santalinus</i> (red sanders)	S. Cuddapah Div. (Madras)	Green
<i>Saccopetalum tomentosum</i>	E. D. Kanara (Bombay)	Green and Klin dry.
<i>Shorea robusta</i> (sal)	Kurseong Div. (Bengal)	Air dry.
<i>Stereospermum chelonoder</i> (padri wood)	S. Mangalore Div. (Madras)	Green.
<i>Tectona grandis</i> (teak.)	Kurseong Div. (Bengal)	Air dry
<i>Terminalia myriocarpa</i> (hollock)	Lakhimpur Div. (Assam)	Green and Klin dry.

List of species tested under Project No. 2.

Species.	From	Condition.
<i>Amoora walliepii</i> (amoora)	Kurseong Div. (Bengal)	Air dry.
<i>Artocarpus chaplasha</i> (chaplasha)	Lakhimpur Div. (Assam)	Air dry.
<i>Chukrasia tabularis</i> (chickrassy)	Kurseong Div. (Bengal)	Air dry.
<i>Dipterocarpus griffithii</i> (gurjun)	Burma	Air dry.
<i>Dulatanga sonneratoides</i> (lamjanti)	Kurseong Div. (Bengal)	Air dry.
<i>Terminalia arjuna</i> (arjun)	Burrauli Div. (Bihar and Orissa)	Air dry.
<i>Terminalia myriocarpa</i> (hollock)	Assam	Green
<i>Terminalia paniculata</i> (kindal)	E. Kanara Div. (Bombay)	Air dry.

About 14,000 mechanical tests and 19,000 physical determinations were made during the year. In addition to computing the routine tests, the computing office prepared a large number of tables for answering enquiries. Numerous computations for the grading of teak squares were also made. These included calculations for about 40,000 c.ft. of timber. This work was done in consultation with the Forest Economist, Burma.

Wood Seasoning Section.

1. KILN DRYING RESEARCH WORK.

In order to study the drying of refractory hardwoods, which dry at a very slow rate, and in which the process of drying is considerably affected by the leakage of moisture through the walls of the kiln, a laboratory kiln was designed and fitted with a metal lining in the interior. The construction of the kiln was completed just after the close of the year under review, and it is hoped to be able to report some progress in this direction next year.

The supply of timber for kiln drying experiments is limited, and such timbers as were available were all reserved either for the furnace kiln, or for the new metal-lined kiln, the construction of which was much delayed by the work which had to be done for the Lucknow exhibition. Only seven charges of timber were dried in the large internal fan kilns, and none of these was actually meant for the kiln drying project. Five out of the seven charges were of *Dalbergia sissoo*, and it is satisfactory to report that in all cases, this timber was dried from a green condition to about 8 per cent. moisture content in ten to twelve days.

In the small laboratory kilns, twelve charges were dried during the year, mostly for the Timber Testing Section. A large number of woods now being tested by the Timber Testing Section are of a highly refractory nature, and their drying offers many difficulties. Nevertheless, as each species and consignment is dried separately in a small kiln, some very useful information is being collected on the drying of some of our more refractory hardwoods.

2. FURNACE KILN.

This kiln has given very satisfactory results throughout the year. In all, 13 charges have been dried so far, out of which 6 were dried during this year. A detailed report of the results obtained up to the end of 1935, was published as Indian Forest Record, Utilization, Vol. 1, No. 3. The following short notes on the woods dried during the year are of interest :—

1. *Dalbergia sissoo*.—Two charges of this wood were dried in the form of one-inch planks. The initial moisture content in one case was 46 per cent. and this was reduced to 8 per cent. in 7 days' drying. Apart from some trifling cracking around knots, and some very slight warping and cupping, there was no appreciable degrade.

2. *Artocarpus chaplasha*, *Palaquium ellipticum*, and *Terminalia bialata* were dried in a mixed charge in the form of one-inch planks. The *Artocarpus chaplasha* contained 35 per cent. moisture, and in 4 days it was dried down to 8 per cent. There was no noticeable degrade of any kind.

3. A charge of *Albizia procera* one inch planks was dried from the green condition, containing over 100 per cent. moisture, in 18 days. The rate of drying of samples was fairly rapid in the beginning, about 13 per cent. in a day, but the rate became slower near the end of the drying process. The timber had some original heart shakes, and it was found that the shakes had opened out during the drying and some collapse and warping was caused by the presence of these shakes. About half the planks showed no degrade of any kind, but on the whole the appearance of the dried material was not very attractive. This was probably because the conditions of drying were too severe in the early stages. A small quantity of this wood, from the same lot and in 1½ inch planks, was included in a subsequent charge (described below) and finished up in a much better condition.

4. A mixed charge of thick timbers, consisting of *Acacia arabica*, *Adina cordifolia*, *Albizia procera*, *Artocarpus hirsuta*, and many other species in small lots, was dried with very satisfactory results. Except for *Albizia procera* which was in 1½" planks, all the species were in the form of 2-inch planks, and were in a green condition to start with. The drying process was completed in 21 days, and it is highly gratifying to note that except for surface discolouration, no appreciable degrade of any kind was noticeable. No increase in end splits and surface cracking was found at the end of drying, the only defect being a little warping in some very wide *Acacia arabica* planks (width up to 32"), a few split knots in the *Adina cordifolia*, and some slight spring in some planks of *Artocarpus hirsuta*. On the whole, the condition of the timber after drying was very good, and the time taken for the drying was certainly less than that required for the same material in an ordinary steam-heated kiln.

3. AIR-SEASONING.

Small quantities of material left over from Project VII experiments were stacked for air-seasoning as usual, and the observations on thick scantlings of eight species, started in the previous year, were continued. An experiment on the seasoning of some refractory hardwoods in the form of logs and half-logs (a log sawn into 2 portions through the heart centre) was completed, and it was noticed that the timber from logs and half-logs seasoned for about a year prior to conversion was in much better condition at the end of the air-seasoning period than the timber obtained direct from green conversion. This was particularly noticeable in the case of *Quercus lamellosa* and *Q. lineata*, from which green conversion into plank material yields no useful timber at all. This method of seasoning may be useful in the case of certain hard and very refractory woods, and it is proposed to investigate the relative merits of green conversion and log seasoning in further detail.

4. WATER-SOAKING PRIOR TO AIR-SEASONING.

The tests on end-matched specimens of various species, seasoned with and without previous soaking in water, are being continued. Some of the specimens are to be left under water for a period of 7 years in order to see the effect of such long soaking. Results so far do not indicate any material difference in the shrinkage and hygroscopicity of wood with and without water-soaking.

5. AIR-SEASONING OF RAILWAY SLEEPERS.

A tour was undertaken by the Officer in Charge, Seasoning Section, to some exploitation areas in the East Almora division of the United Provinces, in order to make a preliminary investigation on the seasoning of chir sleepers from the Kumaon forests. As a result of this tour, a scheme was drawn up for a detailed study of the seasoning of chir sleepers from the stump to the railway track. The experiment will be started during next working season, in co-operation with the United Provinces Forest Department, the Indian Turpentine & Rosin Co., Ltd. (the sleeper contractors) and the Sleeper Control Officer of the Northern Group. All the authorities concerned have expressed their willingness to co-operate. In addition to the effect of various methods of stacking and of the use of end-paints, for which purpose coal tar and chir tar will be tried, the effect of seasoning in the form of logs will be studied. It has been noticed that sleepers obtained from logs left in the forest for about 9 months showed less cracking than those obtained from logs cut up soon after felling, although the difference in the moisture content of freshly felled and seasoned logs was not very appreciable. Possibly seasoning in log form results in some equalisation of stresses in the wood and the point is, therefore, worth investigating.

An investigation on the seasoning of sal sleepers has also been taken in hand and some preliminary investigations were carried out at Kalyan (Great Indian Peninsula Railway) and at some of the sal sleeper depots along the Rohilkund and Kumaon Railway. An experiment to determine the "life" of seasoned and unseasoned sal sleepers has been started in co-operation with the Rohilkund and Kumaon Railway at Lucknow. One thousand metre gauge sleepers were selected for this purpose. Half of these will be laid in the track immediately and the other half after one year's seasoning. The condition of these sleepers will be examined from time to time. The difference, if any, between the average life of the two lots will indicate if there is any benefit in seasoning sal sleepers prior to laying them in the track. At present there is no information on this subject.

The results of the preliminary investigation on the seasoning of sal sleepers were briefly :—

- (i) that sal sleepers in the United Provinces are usually brought to the depots and put up for passing soon after they are cut ;
- (ii) that the sleepers at the time they are taken over by the railways are very green, containing 60 per cent. to 80 per cent. moisture ;
- (iii) that one year's seasoning in close-crib stacks under mild climatic conditions is not sufficient to season them ;
- (iv) that the presence of sapwood in these sal sleepers is responsible for a large percentage of rejections of sleepers from the United Provinces forests. In this respect, the use of treated sapwood sleepers would be a great help, and the matter is now being investigated at the Forest Research Institute. The United Provinces Forest Department has already supplied sapwood sal sleepers for the investigation.

6. ELECTRIC MOISTURE METERS.

In response to a circular letter sent to various government and state departments, and wood working firms, orders were received for 12 meters, and arrangements were made for their manufacture locally. The cost of a meter came to Rs. 175. More enquiries are being received, and it is expected that the demand for these meters will increase with a spread of knowledge about the seasoning of wood.

Further experiments are in hand to increase the range and usefulness of the meter.

7. A SURVEY OF THE MOISTURE CONTENT OF WOOD.

This investigation was inaugurated last year and was continued during the year under report. The data received from various centres are being worked up and analysed as they come in.

8. SHRINKAGE STUDIES.

A large number of shrinkage specimens were kept under observation during the year. Detailed studies are being made of the shrinkage of wood from the green to the air dry condition, as well as the changes in the dimensions of seasoned wood due to fluctuations in atmospheric humidity.

During the year a few experiments on the longitudinal shrinkage of wood were started. The investigation on the effect of impregnation with various chemical substances on the subsequent shrinkage and

swelling of wood was continued. Furfuryl alcohol was tested for impregnating wood and thereafter resinifying the alcohol in the wood by means of dilute acids. Another synthetic resin imported from the United States of America is also being investigated. The results so far do not show more than 30 per cent. to 40 per cent. reduction in the shrinkage and swelling of wood with changes in atmospheric humidity.

9. ACTION OF CHEMICALS ON WOOD.

Experiments to determine the action of various common acids, alkalis, and other chemicals, on Indian woods were started with a view to finding out the suitability of our indigenous timbers for the manufacture of apparatus and machinery for the chemical industry. Such articles comprise filter presses, reaction and crystallization vessels, fermentation and storage vats, etc.

Experiments on the effect of different concentrations of sulphuric acid and caustic soda on the following woods were finished during the year :—

- (i) *Cedrus deodara* (deodar).
- (ii) *Pinus excelsa* (kail).
- (iii) *Pinus longifolia* (chir).
- (iv) *Tectona grandis* (teak).
- (v) *Shorea robusta* (sal).

The effect of soaking the wood for definite periods on the strength of wood was investigated by means of compression parallel to grain and the R. A. F. impact tests. It was found that in compression parallel to grain, the acid did not cause any appreciable weakening of the wood, while the alkali reduced the strength considerably. The R. A. F. impact test, on the other hand, gave very erratic results, the alkali treated wood in some cases being found to be tougher than the water-soaked controls. This point is being further investigated, and during the coming year it is proposed to carry out some static bending tests as well.

10. LUCKNOW EXHIBITION.

A model of the Furnace kiln was prepared and a number of posters were drawn for the Industrial and Agricultural Exhibition held in Lucknow during last winter. A poster illustrating the method of stacking timber for air-seasoning was also printed (in English). This poster was distributed by the Forest Research Institute and translations of it in Urdu and Hindi were later printed and distributed by the Forest Department of the United Provinces.

11. ENQUIRIES.

Drawings showing the detailed construction of the furnace kiln were supplied to more than 10 enquirers, and details about the erection of small steam-heated kilns were also sent to 7 other enquirers who asked for them. The number of important seasoning enquiries dealt with during the year was 56, which shows an increasing interest in the seasoning of wood.

Wood Preservation Section.

INCORPORATION OF A FIREPROOFING MEDIUM WITH ASCU WOOD PRESERVATIVE.

Considerable experimental work was done in this connection and the best results were obtained by employing boric acid with Ascu. Although in most ways the combination appeared to be satisfactory, the fire retarding efficiency of the combination still requires to be improved.

INCORPORATION OF DYES WITH ASCU WOOD PRESERVATIVE.

Ascu, *per se*, does not give any very distinctive colour to some woods treated with it, especially when it is used in low concentrations with brown and other coloured timbers. This lack of colouration is important, as inspecting officers frequently cannot tell whether timber has been treated or not. Attempts were therefore made to mix a dye with Ascu solution. Although several dyes of different kinds and colour were tried, it was found that only "Acid fuchsin" remained stable for any number of days when combined with Ascu. The colour obtained, however, was not very pleasant. It will be necessary to make further experiments on this subject so that, if possible, a pleasant green colour can be obtained.

PRESERVATION AND WATERPROOFING TESTS ON JUTE CANVAS.

Test samples were prepared by treating them with various combinations of Ascu, hide glue and petroleum asphalt. This work was undertaken for the Imperial Council of Agricultural Research. Some of the samples so treated have been submitted to a durability test against termites along with untreated controls, as well as with pieces treated with rubber latex sent for test by Messrs. The Cuprinol Co., Ltd.

HARDENING OF TIMBER.

A few preliminary experiments were made with the object of trying to form putty in wood by impregnating small pieces of timber with a

solution of calcium chloride and sodium carbonate, followed by a linseed oil treatment. As such treatment helps to make wood more moisture resistant also, it would appear that further work in this direction might lead to some useful results.

GRAVEYARD TESTS.

(a) Samples of the following proprietary boards or preservatives sent by different firms were submitted during the year under review to test in the "graveyard" :—

Garostone.

Beaver board.

Sundcalal board (new brand).

Presotim.

Drymol.

Osmose-treated eucalyptus and pine sections.

Woodguard.

Celotex board.

Cuprinol-treated veneers.

(b) Untreated specimens of the following species were laid down in the test yard :—

Heterophragma roxburghii.

Pongamia glabra.

Saccopetalum tomentosum.

Cassia fistula.

WORK IN THE WOOD PRESERVATION PLANT.

A new Ascu pressure wood preservation plant, of which the treatment cylinder is in two sections of 20 ft. length each and with a diameter of 14", was installed during the year. This new cylinder makes it possible for poles and timber up to 40 ft. in length to be treated under pressure with Ascu. Formerly we have not been able to treat such long timbers.

The wood preservation plant was kept very busy during the year treating large quantities of timber for Timber Development, research, and demonstration work, and for fence posts and other requirements of the New Forest estate.

DEMONSTRATION TO THE NORTH WESTERN RAILWAY ON RELATIVE PENETRATION OF ASCU AND COAL TAR CREOSOTE INTO CHIR SLEEPERS.

During the first week of September 1936, Messrs. A. E. Greene, Sleeper Control Officer, N. W. Railway, and H. M. Glover, Conservator of Forests, Eastern Circle, Punjab, visited the Forest Research Institute to witness some comparative tests on the relative penetration of cold Ascu and hot creosote into the heartwood of chir broad-gauge sleepers. One set of halves of 30 chir B. G. sleepers (brought to Dehra Dun from Dhillian) were treated with Ascu under pressure and the remaining halves of the same sleepers were treated with a hot mixture of creosote and crude oil. The sleeper halves were later cut at mid-length to observe the penetration of the preservatives in the heartwood.

In the words of Mr. F. Canning, C.I.E., I.F.S., Officiating Inspector General of Forests at the time, the results of the demonstration may be stated as follows :—

“ The general conclusion regarding the results was that in this batch of sleepers the penetration of sapwood was complete in the case of Ascu and practically complete in the case of creosote. The density of the Ascu preservative in the sapwood was generally markedly greater in the sapwood than in the heartwood. In the creosoted sleepers, penetration in the sapwood was also generally complete, but the density of the creosote in the sapwood did not appear so markedly greater than in heartwood. In a few places in the sapwood probably, it is understood, where there was sap stain, a fungal attack considered not very injurious — the creosote penetration was poor. In the heartwood the penetration both by Ascu and by creosote was erratic and irregular ; in the irregularity of the penetration of the preservatives there was generally more or less correspondence between the penetration of Ascu and of creosote.”

“ The general conclusion was that, while every reservation must be placed against drawing unwarranted assumptions from a single and limited experiment of this nature, it was agreed that in this case penetration of both Ascu and creosote in the heartwood of chir was erratic and that there was certainly nothing in favour of Ascu as regards its penetration as compared with creosote but on the other hand the penetration of creosote was probably slightly better than that of the Ascu.”

“ It may be noted that in two previous experiments of this nature the results were slightly in favour of Ascu as compared with creosote. So far as the evidence before me exists at the present moment I should be inclined to say that if penetration obtained with creosote is considered satisfactory, the penetration of Ascu should be equally satisfactory.

Mr. Glover considered that the penetration which we obtained in this experiment was distinctly better than that which he had observed in the sleepers treated by the Company at Dhilwan."

A report on the whole investigation was later printed (for departmental use only).

Wood Workshop Section.

This section continued to function on a reduced scale as a supply unit for other sections, while the Officer in Charge devoted the greater part of his time to veneer and plywood research and to glue testing. A great deal of the above officer's time was taken up in organising and preparing exhibits for the Lucknow Exhibition.

The Timber Testing Section was supplied with 14,443 wood specimens for test purposes as detailed below :—

The Wood Technology Section was supplied with 8 "Gamble" specimens and 685 hand specimens.

In addition to supplying other sections with converted material for research purposes this Section completed 372 jobs of a varied character including the making of :—

- Handles (various).
- Packing cases (various).
- Tables and exhibition furniture.
- Demonstration bridges (for Lucknow Exhibition).
- Exhibition boards (various).
- Trays (for Lucknow Exhibition).
- An earthquake-proof house (for Lucknow Exhibition).
- Lamp stands.
- Model seasoning kilns.
- Frames (various).
- Boxes (various).
- Stands for exhibits.
- Switch boards.
- Models of houses.
- Rollers.
- Models of furniture.
- Experimental floors.
- Ladders.
- Veneer and plywood panels.

247 logs, 355 sleepers, 60 bolts and 58 poles of various species were converted in the sawmill during the year. The logs and bolts were converted mainly for the Timber Testing, Wood Seasoning, and Wood-working Sections.

In addition to the above, much miscellaneous work was done, such as the preparation of crossers for stacking timbers, the cutting of planks and scantlings for use in other sections, and the cutting of firewood from off-cuts for the furnace kiln.

Reports on the working qualities of specimens of the undermentioned timbers were recorded during the period under review :—

- Podocarpus wallichianus.*
- Pterocarpus santalinus.*
- Bombax malabaricum.*
- Eucalyptus eugenioides.*
- Amoora wallichii.*

Terminalia citrina.

Tectona grandis.

ENQUIRIES.

Various enquiries in connection with woodworking and related subjects (other than veneers, plywood and glues) were received and dealt with.

TESTS.

Project VIII. Tests were carried out on the undermentioned species and the results were sent to the Forest Utilization Officer, Bengal :—

Cryptomeria japonica.

Bucklandia populnea.

Several sets of tests on gluing leatherette on portable gramophones were carried out (using a casein cement of our own formula) for The Gramophone Co., Ltd., Dum Dum, Calcutta, and the results with suggestions, advice and samples were sent to the firm.

Tests were carried out on shellac bounded 3-plywood of hollock for the Director of the Indian Lac Research Institute, Bihar, and the results were reported.

Project VIII tests were carried out on various logs of hollong (*Dipterocarpus macrocarpus*) sent by the Deputy Conservator of Forests, Lakhimpur, Assam, and the results (with samples of the veneers) were reported.

Project VIII tests were also carried out on a log of *Boswellia serrata* for the Dewan of Koren State and the results were reported to him.

TRAINING.

A course of training in plywood manufacture was given to Mr. Manmohan Lal, B. I., a representative of Messrs. The Krishna Roller Flour Mills, Ludhiana. The firm acknowledged their appreciation of the tuition given and wrote "We feel highly grateful to you for your taking a great interest in giving training to Mr. Manmohan Lal our representative who was sent to you for taking training in the manufacture of plywood. We hope his training will be very useful to us for starting a small plant here."

Courses of training in saw-doctoring were also given to selected soldiers from the K. G. O. Bengal Sappers and Miners, Roorkee. This unit now sends their men here regularly for courses in saw-doctoring.

The Commandant of the corps has expressed his thanks for our co-operation in this matter and has stated that the training given is of great value to them.

. . VENEER SUB-SECTION.

Logs of the following species were peeled for routine tests under Project VIII :—

- Boswellia serrata.*
- Terminalia tomentosa.*
- Castanopsis hystrix.*
- Anthocephalus indicus.*
- Michelia champaca.*
- Artocarpus chaplasha.*
- Lagerstroemia flos-reginae.*
- Millettia pendula.*
- Abies pindrow.*
- Gmelina arborea.*
- Pterocarpus macrocarpus.*
- Dipterocarpus turbinatus.*

Many enquiries relating to veneers, plywood and glues were received and dealt with during the year.

TOURS.

The Officer in Charge went to Calcutta and Delhi in the cold weather in order to see what markets exist for veneers of Indian timbers. He took with him samples of veneers and discussed their possibilities with architects, ship-builders, cabinet makers, and interior decorators, etc. The tour resulted in one firm in Calcutta giving a definite assurance that they intended to start operating at the end of this year, so it is hoped that before long a supply of Indian wood veneers will be available for those requiring them.

MISCELLANEOUS.

Mr. A. Gaffar, Student Sleeper Passing Officer, underwent a course of study in the Section in August 1936.

Mr. Ghulam Nabi, Headmaster, Government Wood Working Institute, Jullundur, also underwent a course of study in the Section in August 1936.

At the request of the Engineer-in-Chief, Army Headquarters, Simla, the Officer in Charge of Woodworking, accompanied by the Forest Economist, paid a visit to the K. G. O. Bengal Sappers and Miners Workshops at Roorkee to inspect the Army folding boat and pontoon equipment and to offer suggestions and advice for their improvement.

The Engineer-in-Chief, Army Headquarters, Simla, apparently appreciated the help given. He wrote as follows:—"I wish to convey my thanks to the Forest Economist, to Mr. Nagle, and all members of the Institute, for the trouble they have taken in compiling these most useful reports".

Minor Forest Products Section.

F. R. I. PORTABLE CHARCOAL KILN ("FRIKILN").

The number of enquiries about this kiln increased still further as the result of the publicity given to it at the Lucknow Exhibition, and as the result of a recent poster. The stock of reprints containing a note on the kiln was speedily exhausted. Twenty kilns are now working in various parts of India.

2. CHARCOAL BRIQUETTING.

A note embodying the results of the experiments on charcoal briquetting with different binders was published in the *Indian Forester* of February 1937. It describes the various binders such as cereals, *Bauhinia retusa* gum, tamarind (*Tamarindus indica*) seeds, etc., tried for briquetting charcoal intended for domestic use. The cereals and tamarind seeds are ground into a powder and then boiled in water to form a paste before they are mixed with the charcoal in the grinding mill. Rice (5 per cent.) and tamarind seeds (6 per cent.) gave the strongest briquettes. The cost of briquetting using these binders worked out at Re. 0-3-11 and Re. 0-2-11 respectively per Bengal maund, and they offer therefore commercial possibilities.

3. CULTIVATION OF MEDICINAL PLANTS.

It was mentioned in last year's report that (1) *Datura fastuosa*, (2) *Artemisia maritima* (Kashmir variety), (3) *Solanum indicum*, (4) *Hydrocotyle asiatica*, (5) *Plantago psyllium*, (6) *Menha piperata* and (7) *Carum copticum* were grown successfully in the minor forest products garden. The cultivation of these plants was continued to confirm the previous year's results.

The cultivation of pyrethrum (*Chrysanthemum cincrariacolium*) was also continued. The plants grown from seeds received from Japan and Belgrade were vigorous and healthy and began flowering in May. The flowering period, however, was very short due to the early and heavy monsoon which caused much mortality among the plants. By the end of the monsoon every one of the plants had been killed. Plants were again raised from seeds from plants which had been grown in the minor forest products garden during the previous year. The germina-

tion of these seeds was peculiar in that it continued over a period of two months, a few seeds germinating almost every day during the period. The new seedlings have been transplanted, some to open beds and some to pots. They were healthy at the end of the year under report.

The cultivation of *Derris elliptica* and *D. malaccensis* was continued, but the rate of growth was very low and the root system was poor. These plants cannot apparently be grown on a commercial scale in a climate like Dehra Dun. Some cuttings of the above two species of *Derris* were received towards the end of December from the Malayan Agricultural Department through the courtesy of the Imperial Council of Agricultural Research. The end of December is about the worst time for planting tropical cuttings in Dehra Dun on account of heavy frost, and the cuttings failed to strike root in spite of various devices improvised to keep them warm.

Datura stramonium was tried, but became sickly during the summer and the plants died one by one, apparently unable to stand the dry heat.

Arrangements were made with the Forest Botanist to obtain seeds of medicinal plants from various botanical gardens and universities, etc., in Europe, America, and China, by exchange, and several packets of seeds were received towards the close of the year. Our thanks are due to the Forest Botanist for his co-operation in the matter.

4. MATCH WOODS.

A list of Indian woods tried for match manufacture was published during the year. Anyone interested can obtain a copy by applying to the Utilization Officer, New Forest P. O., Dehra Dun.

5. COLLECTION OF INFORMATION ON DRUGS OF FOREST IMPORTANCE.

This work, which is being carried out in conjunction with the Bio-chemist and the Forest Botanist, was finished during the year, except for the addition of some further information collected recently.

6. OUTTURN OF MINOR FOREST PRODUCTS (DRUGS).

It was mentioned in last year's report that a circular had been sent to all forest officers in India asking for information on the minor forest products within their jurisdiction. Replies have been received from all provinces and from many States, and the information is now being tabulated and recorded. Our thanks are due to all those who responded, for their co-operation in the matter.

7. SUBSTITUTE FOR CORK FOR USE AS INSULATORS IN REFRIGERATORS.

This enquiry was not continued during the year as the production of extremely fine glass wool by a patented process recently discovered in Germany makes any other material uneconomical for the purpose in view.

8. ENQUIRIES.

Over 400 enquiries dealing with the supply, collection, marketing, prices, etc., of minor forest products were dealt with during the year.

Paper Pulp Section.

I. EXPERIMENTAL FACTORY.

1. *Disintegration of bamboos*.—The newly designed feeding equipment to the disintegrator did not give improved results as regards the flattening and partial crushing of bamboo stems. It was consequently decided to have a suitable equipment designed and made by an outside engineering firm. Negotiations in this connection are in progress with Messrs. The Kumardhubi Engineering Works, Ltd., Kumardhubi (Bengal).

2. Semi-commercial tests on *Bambusa tulda* (*mitenga*), *Dendrocalamus longispathus* (*orah*) and *Teinostachyum dullooa* (*dolu*) were carried out and completed. The factory experiments confirmed the laboratory results as regards the suitability of the above species for pulp and paper making. Factory trials were also carried out on the production of pulp and paper from a mixed lot of the following five species from Bengal :—

- (1) *Oxytenanthera auriculata* (*kuliseri*).
- (2) *Dendrocalamus hamiltonii* (*kokwa*).
- (3) *Dendrocalamus longispathus* (*orah*).
- (4) *Bambusa tulda* (*mitenga*)
- (5) *Teinostachyum dullooa* (*dolu*).

Equal quantities of each of the five species were taken, and the digestion, bleaching, etc., were carried out under normal routine conditions. The yields of pulp and paper and the quality of paper produced were about the same as those for the individual species, thus showing that mixed species of bamboos could be used for the manufacture of pulp or paper on a large scale.

3. Pulp and paper making tests were carried out on *Anthistiria gigantea* (*ulla* grass) from Kheri division, U. P. The grass gave poorer results than those obtained in 1934 from a consignment of the same

grass from the same division. Not only were the yields of pulp and paper appreciably less, but both pulp and paper showed shives, in spite of the more drastic bleaching treatment employed. On enquiry it turned out that the first lot (1934) was cut from a fire-protected area and the second lot (1936) from an area subjected to annual burning. This factor might have had an influence on the quality of the two lots. There are other factors, however, which might also have influenced the quality. They are (1) the different times of the year at which the two lots were cut, (2) the different ages of the two lots, and (3) the quality of the soil and drainage of the ground on which the two lots were growing. In order to find out exactly which factors are likely to influence the quality of grass for paper-making, it is proposed to obtain small samples of the grass from different areas, cut at different times of the year, and to test them in the laboratory for yield of cellulose and consumption of chemicals. The Conservator of Forests, Eastern Circle, U. P., has already made arrangements for the supply of the different samples.

4. Paper-making trials were carried out on *Saccharum munja* (*munj* grass) sent by the Radhasoami Satsang Sabha, Dayalbagh, Agra. The quality of the paper obtained was fairly satisfactory, but the consumption of chemicals was rather high. Further experiments will be carried out to try and reduce the consumption of chemicals.

5. A series of paper runs were made, using the samples of Indian china clays sent by Messrs. The Titaghur Paper Mills Co., Ltd., The Bengal Paper Mills Co., Ltd., and The India Paper Mills Co., Ltd., and a sample of English china clay, to test the comparative suitability of various clays as paper fillers. The experiments show that the Indian china clays are quite suitable and satisfactory and they are also reported to be cheaper than imported clays.

6. Experiments were carried out on the production of kraft pulp and paper from *Dendrocalamus strictus* (*salia*), sent by Messrs. The Orient Paper Mills Co., Ltd., and *Dendrocalamus longispathus* (*orah*). Whilst fairly satisfactory pulp was obtained, the paper produced was poor in strength, partly owing to defective press rolls on the paper machine and partly due to the lack of a jordan or refine in the experimental factory. The experiments will be continued after the press rolls have been put right. The indications that good kraft can, however, be made in India from bamboos, are distinctly hopeful.

7. Packing paper was prepared from bagasse (crushed sugar cane) for exhibition in the Sugar Court at the Agricultural and Industrial Exhibition at Lucknow.

8. *Manufacture of paper, boards, etc.*—About four tons of writing, printing, type and packing papers and mounting and drying boards were produced in the experimental factory during the year under report.

About 2½ tons of paper and boards were supplied to the various offices of the Forest Research Institute and College, to the Government of India Press for the annual report, and to the Silviculturist, Punjab, and the Forest Research Officer, Bihar, for some special work.

9. The erection of the small mechanical pulp grinder obtained from Messrs. J. M. Voith (Germany), was completed towards the end of the year under report. Experiments on production of mechanical pulp from bamboos and a few selected species of soft woods will now be taken in hand.

II. LABORATORY.

1. *Pulp for artificial silk.*—Experiments on the purification of bamboo pulp for the rayon and staple fibre industries were discontinued, pending the report of investigations by the Industrial Research Bureau on the possibilities of starting such industries in the country.

2. Experiments on the digestibility and bleachability of bamboo chips, supplied by the Kankinara Paper Mills, the Bengal Paper Mills and the India Paper Pulp Co. were completed and a report was made to the Paper Mills. The results confirmed the expectation that the opening out and the partial crushing of chips helped considerably in obtaining uniformly well digested and economically bleachable pulp.

3. Investigation on the causes of discoloration of bleached pulps and papers (one of the problems referred to the section by the Indian Paper Makers Association) was taken in hand. No conclusive results have yet been obtained.

4. Physical tests (tensile, bursting, folding, tearing, bulk, etc.) on papers prepared in the factory in connection with the experiments on the suitability of Indian china clays, were carried out and tabulated. The physical properties (specific gravity, grit, water of combination, etc.) of the various samples of clays were also examined.

5. Kraft pulps were prepared from *Dendrocalamus strictus* and their strengths (tensile, bursting and tear) were compared by the standard British Pulp Evaluation method with samples of three brands of wood kraft pulp obtained from Sweden. The samples of the Indian bamboo pulp sheets, gave a higher breaking length and burst factor than those of the pulp sheets prepared from the Swedish pulps. This demonstrates that it is possible to produce kraft papers from bamboo as good as the wood-pulp kraft papers imported into this country from Sweden.

Strength tests (tensile and bursting) were also carried out on ten different samples of Swedish Kraft papers, obtained from Messrs. The Vulcan Trading Co., Bombay.

6. Four grasses, *munj*, *kans*, *dab* and *gandor*, supplied by the Radha-soami Satsang Sabha, Dayalbagh, Agra, were tested for the production of bleached and wrapping papers.

7. Pulp and paper-making tests were carried out on *Andropogon schoenanthera* (bohra grass) at the request of the Working Plan Officer, No. II Anantpur division (Madras).

8. *Boiler feed water*.—Routine analytical tests in connection with the softening of the boiler feed water were carried out as and when required.

III. TOURS AND ENQUIRIES.

1. At the request of the Mysore Government, Mr. Bhargava visited Bangalore and Bhadravati in June 1936, to give advice to Messrs. The Mysore Paper Mills Co., Ltd., regarding the specifications of machinery for the Mills and other matters connected with the project of manufacturing paper in the State.

2. In August 1936, Mr. Bhargava visited Dayalbagh, Agra, to discuss a project for the manufacture of paper from grasses grown on the estate.

3. In September 1936, Messrs. The Orient Paper Mills Co., Ltd., invited Mr. Bhargava to Calcutta to discuss their project for the manufacture of paper.

4. Correspondence was carried on with Government departments, commercial firms and private individuals in connection with the technical enquiries referred to the section from time to time.

IV. TRAINING OF APPRENTICES.

At the request of the Siam Government, two apprentices, Nai Sawai Supayasermsri and Nai Pairojna Dharmatcha, were admitted to the section, in September 1936, for training in the technology of bamboo pulp and paper manufacture. The apprentices have nearly completed their course of training.

V. FOREST UTILIZATION CONFERENCE.

The Forest Utilization Conference, held at Dehra Dun in March 1937, recommended the following species to be tested for the production of mechanical pulp :—

1. *Broussonetia papyrifera*.
2. *Pinus longifolia*.
3. *Macaranga* spp.
4. *Excoecaria agallocha*.
5. *Bombax malabaricum*.
6. *Erythrina suberosa*.

7. *Butea frondosa*.
8. *Boswellia serrata*.
9. *Eucalyptus globulus*.
10. *Sterculia* spp.
11. *Abies pindrow*.
12. *Picea morinda*.
13. *Kydia calycina*.
14. *Gmelina arborea*.
15. *Tetrameles nudiflora*.
16. *Mallotus philippinensis*.
17. Teak saplings.

Experiments on *Broussonetia papyrifera* and *Pinus longifolia* have recently been taken in hand.

VI. GRANTS.

1. The Indian Paper Makers' Association (Messrs. The Titaghur Paper Mills, The Bengal Paper Mills, The Indian Paper Pulp Co. and The Deccan Paper Mills) contributed during the year Rs. 3,250 and Messrs. The Upper India Couper Paper Mills, Lucknow, Rs. 250 as a voluntary grant towards the expenses of the research work being done at Dehra Dun on problems of importance to the paper industry. These grants made by the Indian mills symbolizes the recognition of the value of research by the industry and insures close co-operation between the paper mills and the Forest Research Institute. Such co-operation can but react to the benefit of the industry generally.

2. The Imperial Council of Agricultural Research has also made a grant of Rs. 15,000 to the Forest Research Institute, for investigating the possibilities of manufacturing wrapping papers, insulation boards, straw-boards, etc., from bagasse (crushed sugar cane). Arrangements for carrying out the investigations are well under way and it is expected that experiments will shortly be started.

Timber Development Section.

This section was inaugurated from 1st April 1936.

The Timber Development Officer made a start by writing up some short popular booklets on the following subjects :—

1. Wood's challenge to steel and concrete.
2. Relative economy of wood, steel and concrete structures.
3. Manufacture of small dimension stock as a rural industry.

4. The truth about fire hazard in timber structures.
5. Cheaper and better gable roofing with wood shingles.
6. Treated wood for earthquake resistant structures.
7. Treated wood poles for electric distribution and service.
8. Preservation of Indian wood with Ascu wood preservative.
9. Special factors affecting timber design.
10. Better and cheaper fencing.
11. How to build earthquake and storm-proof houses.
12. Superiority of treated wood as modern structural material.
13. Relative cost of treated electric poles and overhead construction in India and abroad.
14. Specifications for treating wood poles for overhead electrical construction.
15. Treated timber bridges for Indian highways and railways.
16. The role of timber in hangar and aerodrome structures.
17. Wood versus steel for framed buildings.
18. How to build fire-resistant timber structures.

In addition, several thousand leaflets describing the demonstration treated timber house, the demonstration treated timber highway bridge, and the demonstration laminated wood bowstring foot-bridge erected at the Lucknow Exhibition were distributed free to visitors at the Exhibition and to many engineers and others likely to be interested.

TIMBER DEVELOPMENT DEMONSTRATION AT THE AGRICULTURAL AND INDUSTRIAL EXHIBITION, LUCKNOW.

The Timber Development Officer designed the two demonstration timber bridges and the all-wood earthquake and termite resistant house at the Lucknow Exhibition. These were greatly appreciated and provided an impetus to the cause of wood in two important lines, namely highway bridges and earthquake resistant houses. One of the two bridges was designed for 8 British units of highway loading and had a clear span of 48 ft. and a width of roadway of 16 ft. No structural member of this bridge was longer than 25 ft. and no cross-section was larger than 12" x 12". All the bridge truss members were treated under pressure with Ascu. The bridge was successfully tested at Dehra Dun by loading it with a 12½ ton steam road roller and by having about a hundred men standing on it at the same time.

The second bridge put up at the Lucknow Exhibition was of a laminated type, in which the compression member was an arched bowstring consisting of sections not longer than 6 ft. each. The bridge was used

as a foot-bridge leading up to the house over some water and had a span of 22 ft. This bridge was designed to show that such bridges are very practicable. Bridges of this type can be used up to spans of about 100 ft. The sections can easily be standardized, and made on mass production lines, so that portable foot-bridges for longer spans are also practicable.

The all-wood demonstration house had 8 rooms (five downstairs and three upstairs). It had also an open cantilever verandah, and two glazed verandahs on the first floor and a good open verandah on the ground floor on the front side of the house. Two kinds of roofing, one of which was under experiment, were used on the house. A type of box-girder roofing, using Ascu treated 3 and 5-plywood, was provided for part of the roof and the remaining part had Ascu treated wood shingles. The experience gained at the Exhibition with the two types of roofing showed, that for conditions in India, the shingle roof is superior. In conclusion it may be said that this exhibition house definitely served its purpose in stimulating interest in treated wood structures.

TESTS WITH TREATED PLYWOOD FOR CHEAP ROOFING.

Several test roofing panels of 3-plywood and 5-plywood were installed in the Wood Preservation test yard on a framework at a sloping angle before the rains started in June 1936. Some of the panels were treated with Ascu alone and some were given a supplementary treatment with either petroleum asphalt suspended in crude oil, or with petroleum asphalt alone. Fine gravel was sprinkled over the asphalt when it was hot. After 9 months' exposure to the elements, including about 100 inches of rain, the indications are that all the joints of the treated panels, which were of imported alder, have stood up very satisfactorily against rain. The chief defect appears to be superficial splitting, which does not however appear to become much worse after the first 6 months. Observations will continue to be made on these panels and a note made in next year's report as regards their condition.

COLLECTION OF INFORMATION REGARDING THE AVAILABILITY OF COMMERCIAL TIMBERS.

During the year, questionnaires were sent out to all provincial Forest Departments asking for information regarding the availability of those species which might command good markets if treated with an efficient wood preservative. Considerable information of value has been collected as the result of this investigation.

COLLECTION OF INFORMATION REGARDING THE COST OF ENGINEERING STRUCTURES USED IN PUBLIC WORKS DEPARTMENTS.

Questionnaires were also sent out during the year to the Chief Engineers of provincial Public Works Departments asking for information on the cost of the more important types of engineering constructions used by the department. Replies from most provinces have been received.

TREATED WOOD POLES FOR OVERHEAD ELECTRICAL TRANSMISSION.

It is gratifying to record that as a result of the activities of the Timber Development Officer, practically all provincial Electric Inspectors have removed the ban on the use of treated wood poles by electrical licensees. This has resulted in numerous enquiries and schemes for utilising treated wood poles in place of the usual metal pole.

TOUR FOR TIMBER DEVELOPMENT.

At the commencement of the year the Timber Development Officer toured India and met and conferred with several heads of Departments in Assam, Bengal, Bihar, the United Provinces, the Punjab, the North-West Frontier Province, the Central Provinces, Bombay Presidency and Madras Presidency. He also discussed the possibility of a more extended use of treated timber in harbour construction with the Chief Engineers of the Port Trusts of Calcutta, Bombay, Madras, Cochin and Vizagapatam.

INSTALLATION OF ASCU WOOD PRESERVATION PRESSURE PLANTS.

At the commencement of the year, when the Timber Development Section was inaugurated, there were in India only two Ascu wood preservation plants working under the auspices of the Agriculture and Fisheries Department of the Madras Government, and two wood preservation plants belonging to the Ascu Wood Preserving Agency. During the year under review, the Government of Travancore started operating a large-sized plant and they have already treated a few thousand poles for electrical distribution purposes. The Government of Mysore also treated over a lakh of metre gauge and narrow gauge sleepers with Ascu, mostly of *Dipterocarpus indicus*. Several thousands of these sleepers were for the Madras and Southern Mahratta Railway. Messrs. Callender's Cable & Construction Co., Ltd., put up Ascu pressure treating plants in the United Provinces, Bihar, Bengal, Madras and Bombay. These plants were all designed to treat timbers up to 40 ft. in length and 18" in diameter. The Forest Department of the United Provinces also put up a small portable Ascu pressure plant in Haldwani division. The Government Carpentry School at Jullundur put up an Ascu pressure

plant. Building contractors in Amritsar and Lucknow put up two more Ascu pressure plants. The Vizagapatam harbour authorities started operating their Ascu pressure plant, and the State Engineer of Bastar started treating timber with Ascu under pressure in a 40 ft. cylinder. The Government of Mysore have expressed their intention of putting up a second plant for treating timber with Ascu. The Government of Hyderabad have also expressed their desire to put up one large-sized Ascu pressure treating plant and one small-sized experimental Ascu pressure treating plant. The State of Jodhpur and the Zamindari of Balrampur have placed orders for two Ascu pressure plants. In short, at the end of the year under review, there were twenty Ascu pressure wood preservation plants either actually functioning or definitely on order.

In view of the above facts it would appear that commercial wood preservation has definitely come to stay in this country. It is expected that there will be further developments to report by the end of next year.

Apologies are due to the Government of the Federated Malay States for the statement made in last year's report that the Government of the Federated Malay States had definitely decided to put up an Ascu plant. The mistake was due to a misunderstanding. Some experimental treatment with Ascu is being done in the Malay States but this is being done in an existing plant.

DEPUTATION OF OUTSIDE OFFICERS TO DEHRA DUN TO INVESTIGATE TREATED TIMBER UTILIZATION.

Mr. D. G. Plumley, State Engineer of Bastar State, and Mr. Jagdish Prasad, a Public Works Department engineer of the United Provinces, were deputed to the Forest Research Institute by their respective Governments to investigate and report on the question of a more extensive and efficient utilization of indigenous timbers in constructional work. It is understood that the latter's report is being printed. The draft reports of these two officers were very favourable to the cause of timber.

Mechanical Sub-Section.

1. Due to the heavy rush of work experienced during the year the existing staff was not found adequate to cope with all the orders. Nevertheless 500 jobs were completed during the course of the year, in addition to the usual large number of jobs of everyday routine.

2. In the Paper Pulp Section considerable alterations were made during the year under review. The lean-to machine shop on the north side of the paper pulp workshops was extended to take more machines. A 30 H.P. motor was installed there after providing the required electric

mains to run it. A main shaft drive for this motor was also installed. The new mechanical pulp grinding machine was erected in the extension on receipt. The disintegrator was dismantled from its old position and erected in a different position. The bamboo and grass cutting machines were also installed in their new places, and a press was made for making sheets of fibre boards from bagasse. The old defective digester was taken down and discarded. Specifications were prepared for a new digester and the digester itself was received at the end of March. New rustless steel liners for the rod mill were received during the year, and after removing the old ones, the new ones were grouted into position with the help of molten zinc. The chemical laboratory of the Paper Pulp Section was also extended and water and gas connections were provided. The south verandah of the Paper Pulp hall was enclosed for use as a paper store. The new laboratory beater, the standard pulp sheet machines and a pulp press were also installed.

3. In the Seasoning Section, one of the four new kilns of improved design was completed during the year. One of the humidity chambers was lined with galvanised sheeting, and a new door of an improved design was made and tested successfully. One very delicate piece of apparatus was made for the measurement of the diffusion of moisture in wood. Another delicate piece of apparatus of pure copper was built for the measurement of the thermal conductivity of wood and other insulating materials including liquids. Two sets of the various parts of the new electric moisture meters were made for trial purposes.

4. In the Timber Testing Section one Buckton machine was given a complete overhaul.

5. In the Wood Preservation and Timber Development Sections numerous heavy fittings were made for the three wooden bridges for the Lucknow Exhibition. A large number of fittings and bolts were also made for the wooden house for the Lucknow Exhibition. A small Ascu plant was erected and connected up with the laboratory plant.

6. On the electrical side, the three D. C. generators with their switch boards, all the electric motors of various sizes and their switch gear, all light and power wiring circuits, ceiling and table fans, and other miscellaneous electrical appliances in the laboratories of all branches were maintained in good order.

7. The 4 motor lorries, the fire appliances in the Institute, and the railway track and trucks were maintained in good order. The steam boilers were also maintained in good order.

CHAPTER VI.—CHEMISTRY BRANCH.

The following programme of work was undertaken during the year under report :—

1. General study of the chemistry and commercial uses of the minor forest products.

A.—Drugs :—

- (i) *Vitex negundo*, Linn. and *V. peduncularis*, Wall.
- (ii) *Curcuma angustifolia*, Roxb.
- (iii) Fish poisons.

B.—Oils and Fats :—

- (i) *Ximenia americana*, Linn.
- (ii) *Litsaa chinensis*, Lamk.
- (iii) *Bauhinia variegata*, Linn.

C.—Other products :—

- (i) *Eupatorium odoratum*, Linn.
- (ii) *Osyris tenuifolia*.
- (iii) *Saussurea lappa*, Clarke.

2. Forest Soils.

3. Miscellaneous enquiries.

1-A.—Drugs.

(i) *Vitex negundo*, Linn.—It was reported last year that new leaves of the plant (March-April) contain a glucoside (M. P. 154° C.) which in mature leaves is absent. It was also reported that this glucoside on hydrolysis with alkali breaks up into para-hydroxy-benzoic acid and another crystalline glucoside (M. P. 173-74° C.). Further work on the elucidation of its chemical constitution indicates that the molecule of the glucoside consists of three parts namely, glucose, para-hydroxy-benzoic acid and an unidentified substance, which is extremely sensitive to acids, least trace of which even at room temperature decomposes it into a dark brown amorphous substance, insoluble in any of the common solvents. Chemical investigation had led to our suggesting a tentative formula $C_{20}H_{24}O_{11}$ for the parent glucoside and $C_{13}H_{20}O_9$ for the second. Further work is in progress to isolate and identify the third part of the molecule of the glucoside.

Vitex peduncularis, Wall.—The leaves on successive extraction with different solvents yielded 3.7 per cent. extractives to petroleum ether; 2.5 per cent. to ether sulphuric; 1.3 per cent. to chloroform; 10.2 per

cent. to alcohol and 11.9 per cent. to water. The ether and chloroform extracts mainly consist of fats, resins, etc. But from the alcoholic extract an amorphous glucosidal substance has been isolated. Both the glucoside and its hydrolysis product being amorphous, much progress could not be made. This, however, is being examined in greater detail. Apart from the glucoside, a minute quantity of an alkaloid has also been isolated.

(ii) *Curcuma angustifolia*, Roxb.—Roots of various species of *Curcuma* are said to be pharmacologically active and in the Ayurvedic system of medicine are prescribed for various ailments. The main constituent of the roots is starch, though some possess varying amounts of essential oil and colouring matter also. The nature of the starch from *C. angustifolia* does not appear to have been studied, even though it is an article of trade (known as *taukir* or *tikhur* in Madras and Travancore) and the starch is considered as good as the true arrowroot and is given to infants and invalids. The sample of *Curcuma* examined here gave on successive extractions with different solvents the following percentages of extracts :—

	Per cent.
Petroleum ether	0.0
Ether	3.0
Chloroform	0.7
Alcohol	0.1

The roots contained traces of sugars and 60.0 per cent. of starch.

There appears to be some doubt as to its correct botanical identity and therefore detailed examination has been left over for future work.

(iii) *Fish poisons*.—During the year we have explored several other plant products which are reputed as fish poisons. Of these only *Millettia pachycarpa*, Benth., roots have given rotenone, total ether extractives being 3.5 per cent. At present, our work on fish poisons is only of an exploratory character and we are concentrating attention to discover those that contain rotenone or allied products, thus obviating, for the present, the tedious biological experiments which alone are the final test for their insecticidal value.

The existence of rotenone in *Millettia pachycarpa* is both interesting and important and work on this will be extended. The proper age of the roots and the season of collection appear to be important points to bear in mind. The other species *Millettia auriculata*, Baker, which is a pest in some of our forests, has not yet yielded any rotenone but the work is being continued.

It would be interesting to add that work on fish poisons is attracting the attention of the Government, and the Imperial Council of Agricultural

Research have spent, during the last year and a half a considerable sum of money on exploratory work.

1-B.—Oils and Fats.

(i) *Litsrea chinensis*, Lamk. Syn., *L. sebifera*, Pers. vern. *Maida Lakri* (Hind).—The work on extraction of lauric acid has already been mentioned in the past reports and it has now been extended to *L. chinensis* which grows commonly in some of the forests in the United Provinces. Its berries yield 64.74 per cent. of kernels containing 36.56 per cent. of a crystalline fat of the following constants:—

Specific Gravity at 30° C.	..	..	..	..	..	0.919
Refractive Index at 30° C.	..	..	..	..	..	1.4451
Iodine value (Hanus)	..	..	..	..	..	6.3
Saponification value	..	..	..	..	..	274.1
Acid value	..	..	..	..	..	4.5

Further work has shown that the fat consists of 93 per cent. of trilaurin and as such it adds another source for the exploitation of lauric acid.

(ii) *Ximenia americana*, Linn.—A detailed examination showed that the main constituent glycerides in the oil are cerotic (15 per cent.); ximenic (hexacosenic) (15 per cent.); oleic (61.0 per cent.) and linoleic (7 per cent.). The interesting feature of this oil is the presence of a new unsaturated acid, ximenic acid, which has not hitherto been reported to be present in vegetable oils and fats. It belongs to the oleic acid series, forms a dihydroxy derivative M. P. 118-119° C. and on catalytic reduction is converted into cerotic acid. Further work on the elucidation of its chemical constitution is in progress.

1-C.—Other Products.

(i) *Eupatorium odoratum*, Linn.—The Eupatorium of American origin is known to yield essential oils, the main constituent of which is dimethyl ether of thymohydroquinone. The Indian species do not appear to have been studied and it was thought desirable to take up this investigation. Collection of this plant material was made in Assam but when received in Dehra Dun it had dried up and lost almost the whole of its essential oil, the yield being only 0.1 per cent. The oil was dark-green in colour, of density 0.9513 and refractivity 1.4975 at 20° C. A detailed examination of the oil will be made as soon as sufficient quantity of the plants is available.

(ii) *Osyris tenuifolia*.—Reference was made to the so-called East African sandalwood oil last year and the constants of the oil from Tanganyika were given. In order to be certain of the genuineness and

purity, it was thought desirable to distil the oil in Dehra Dun from the stem and roots of *O. tenuifolia*, both obtained from Tanganyika. Both the stem and the roots had 13.3 per cent. moisture and 3.6 per cent. of the light yellowish brown essential oil, having an odour similar to that of the Indian sandalwood oil but fainter and more pungent. The constants for the oil distilled in Dehra Dun and that obtained from Tanganyika are given below :—

	Distilled in Tanganyika.	Distilled in Dehra Dun.
Colour	Light yellow.	Light yellow.
Specific gravity at 20° C.	0.9574	0.9497
Refractive index at 20° C.	1.4996	1.5000
Angle of rotation	—47.1°	—55.47°
Ester value	Nil	16.4
Ester value after acetylation	181	220.

It is obvious from the above that the oil distilled in Dehra Dun is richer in alcohols. To determine the amount of santalol, the oil was fractionated at 4-5 mm. pressure when about 65 per cent. distilled at 160-165° C. This was the main fraction consisting mainly of the free alcohols and had a specific gravity 0.9526 at 20° C.; refractive index 1.5010; angle of rotation —58.14°; ester value 14.9; and ester value after acetylation 233.86. It reacted readily with phthalic anhydride to form an acid phthalate, a thick viscous oil, and attempts to obtain strychnine phthalate compound resulted in getting a viscous oil. On regenerating the sesquiterpene alcohols from this by saponification with alkali and steam distillation, an oil was obtained which resembled santalol in smell and had the following constants :—

Density at 20° C.	0.9771
Refractive index at 20° C.	1.5030
Angle of rotation	—43.5°

These constants are well within the limits for α and β santalol but its further confirmation is necessary. On the presumption that the purified oil is santalol it represents about 45 per cent. on the original oil. This work is being continued.

(iii) *Saussurea lappa*, Clarke. vern. *Kuth*.—Further work on *kuth* (Costus root) grown in British Garhwal confirms the statement made last year that this product compares very favourably with that of Kashmir. The following table gives the description and essential oil contents of the samples analysed :—

	Oil per cent. on zero mois- ture basis.
Moisture per cent.	
Roots from Bhuna nursery (10,500'), 1931 plants, col- lected in September 1936	15.3 3.1
From Bistola nursery (11,500'), 1931 plants (direct sow- ing) collected in September 1936	14.2 4.2

The roots from Kashmir, on average, contain 2—4 per cent. oil, according to age

2.—*Forest Soils.*

An attempt is being made to study the nature of forest soils and for this purpose data is being collected. Soils from typical forests of *Acacia* *sundra*, *Shorea robusta* and *Tectona grandis* have been examined but the work is yet in a preliminary stage and it is premature to report results and conclusions. A number of analyses of stray samples of soils, received from forest officers, have also been carried out.

3.—*Miscellaneous Enquiries.*

(i) Certain manufacturers complained to us that match splints, from semal (*Bombax malabaricum*) grown in the United Provinces, are too dark, which colour deepens further on processing and that they therefore compare unfavourably with semal from Assam. On examination, it was noticed that the red brown colour was not on the surface only but permeated all through the cells of the wood. Solvent extraction removed the colouring matter which on examination was found to be acidic in nature. Consequently an alkali treatment followed by slight bleaching appeared to be the solution of the difficulty. After a series of tests, it was found that soaking of the splints in 1 per cent. caustic soda and subsequent bleaching with calcium hypochlorite (Perchloron) of strength—0.35 pts. in 100 pts. of water gave satisfactory results and the finished splints were very much lighter in colour.

(ii) A large number of analyses were undertaken on behalf of forest officers, officers of the Institute and other departments of the Government, and of these mention may be made of the following :—*Artemisia maritima* ; tree killers ; arsenated pulp boards ; *Betula* sp., etc.

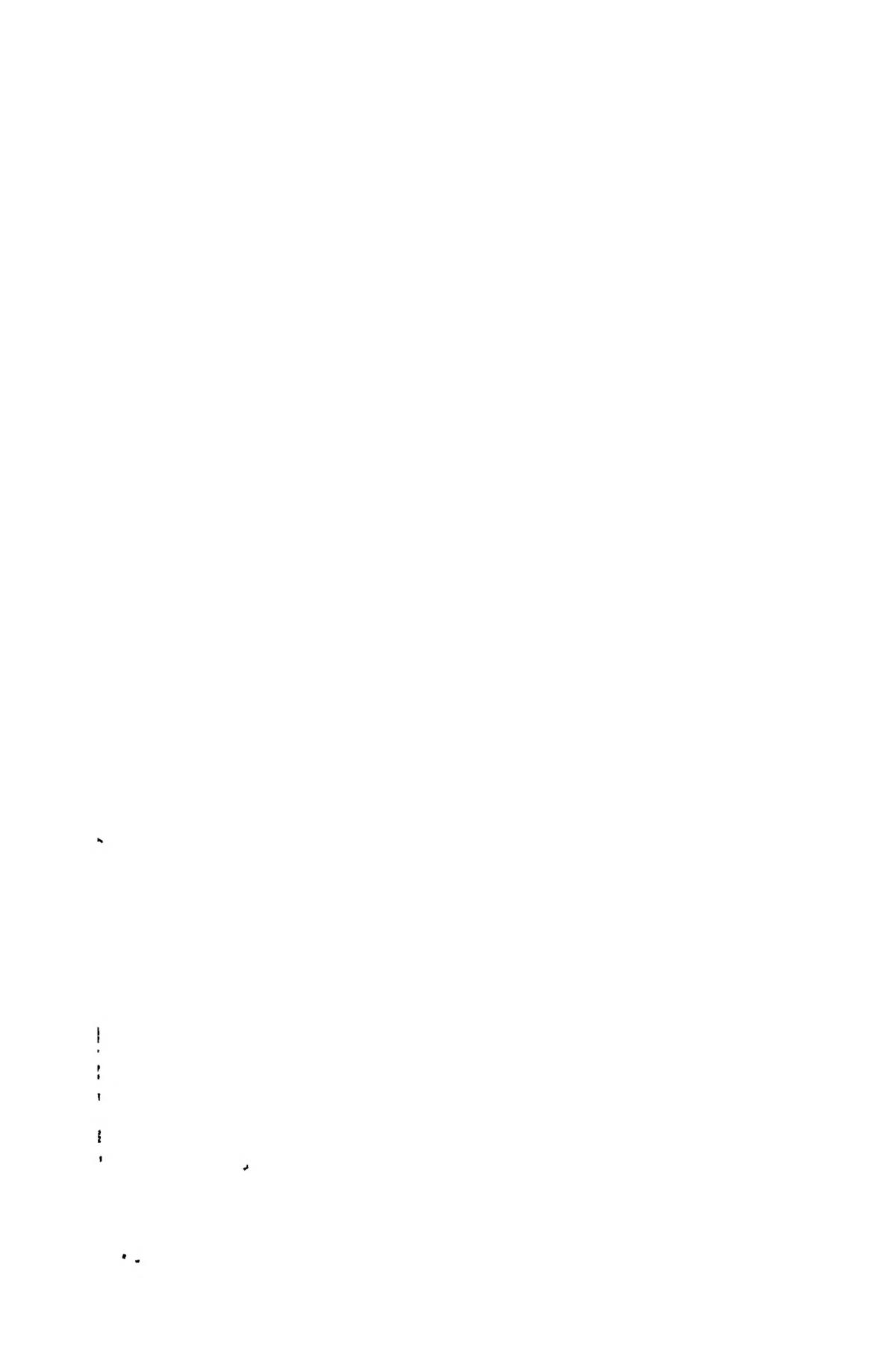
Summary.

It has already been reported last year that the study of *Vitex negundo* and *V. peduncularis* was taken up with a view to discovering the active principle responsible for the medicinal properties attributed to these in the Indian system of medicine. *Vitex peduncularis*, for instance, is a well-known remedy for black water fever. Our investigations have shown that it contains a glucoside and an alkaloid, identity of both of which has not yet been established. From *V. negundo*, on the other hand, has been isolated a glucoside, constituents of which are glucose, para-hydroxy-benzoic acid and an unidentified substance. To para-hydroxy-benzoic acid could be attributed the antipyretic and disinfectant properties of this drug.

Of the fish poisons that are under investigation the discovery of rotenone in *Millettia pachycarpa* is interesting.

The study of the indigenous sources of lauric acid which has been mentioned in previous reports, has now been extended to *Litsca chi-nensis*, the fat of which contains 93 per cent. of trilaurin. Another oil that has been investigated during the year is from the seeds of *Ximenia americana*. The discovery of a new fatty acid, which has been designated as Ximenic acid, is of interest.

Under the heading of essential oil has been mentioned the pleasant smelling oil from *Osyris tenuifolia* which grows in East Africa. The oil is very similar in odour to sandalwood oil and contains about 45 per cent. of a sesquiterpen alcohol which probably is santalol but its identity requires confirmation.



APPENDIX I.

Publications of 1936-37.

Serial No.	Title of Publication.	Author.	Date of issue.
FOREST RECORDS.			
1	Preliminary Survey of the Forest Types of India and Burma.	H. G. Champion .	August 1936.
2	Results obtained with a timber drying kiln heated directly by Furnace Gases.	S. N. Kapur .	July 1936.
3	Standard and Commercial Volume Tables for <i>Dalbergia sissoo</i> .	M. A. Kakazai .	July 1936.
4	A Stand Table for Chir evenaged high Forest .	....	August 1936.
5	Minor Forest Products of Chakrata, Dehra Dun, Saharanpur and neighbouring Forest Divisions; Part 1.—The Oil Bearing Seeds	S. Krishna, S. V. Puntambekar and M. B. Rizada.	January 1937.
6	Entomological Investigations on the Spike Disease of Sandal (27) Chrysomelidae.	N. C. Chatterjee & G. D. Bhasin.	July 1936.
7	A Survey of the damage to teak timber by the Buehole-borer throughout the main teak-bearing forests of Burma.	D. J. Atkinson .	December 1936.
8	Immature Stages of Indian Coleoptera (19) Anthribidae.	J. C. M. Gardner .	August 1936.
9	Entomological Investigations on the Spike Disease of Sandal (28) Cleridae (Hompt.).	N. C. Chatterjee .	August 1936.
10	New Indian Cerambycidae	J. C. M. Gardner .	August 1936.
11	New Indian Tingtidae	C. J. Drake & M. E. Poor.	July 1936.
12	Zwei neue Callirrhipi mit ihren Larven (Sandalidae, Col.).	Fritz van Emden .	August 1936.
13	A note on Protecting Indian Structural Timbers against fire, termites, borers and fungi (rot)	S. Kameyan .	October 1936
14	The formation of Heartwood and its amount in Deodar Timber.	M. A. Kakazai .	(In Press.)
15	Entomological Investigation on the Spike Disease of Sandal (32) Lygaeidae (Hemipt.)	N. C. Chatterjee .	(In Press.)
16	Cis Latr. et Anobidae nouveaux des Indes . .	M. Pic . . .	(In Press.)
17	Immature Stages of Indian Coleoptera (22)	J. C. M. Gardner .	(In Press.)
18	New Cro-sotarsus (Platypodidae Col.) . .	C. F. G. Beeson .	(In Press.)
19	Seed Weights, Plant percents., etc., for forest plants in India	J. N. Sen Gupta .	(July 1937.)
20	Indian Terminations of the section of Pentaptera .	C. E. Parkinson .	(July 1937.)
21	Illustrations of Indian Forest Plants, Part IV .	C. E. Parkinson .	(July 1937.)
22	Entomological Investigations on the Spike Disease of Sandal (29) Coreidae & Berytidae (Hemipt.)	N. C. Chatterjee .	October 1936.
23	Some new Carabidae from India	H. E. Andrews .	December 1936
24	Immature Stages of Indian Coleoptera (20) Carabidae.	J. C. M. Gardner .	December 1936.
25	Neue Bremthilden und Lyctiden aus Indien . .	R. Kleine . .	January 1937.
26	Entomological Investigations on the Spike Disease of Sandal (30) Reduviidae (Hemipt.)	N. C. Chatterjee .	December 1936.
27	On the Biology of the Bostrychidae	O. I. C. Beeson & B. M. Bhatia.	March 1937.

Publications of 1936-37—contd.

Serial No.	Title of Publication.	Author.	Date of issue.
FOREST RECORDS—contd.			
28	Entomological Investigations on the Spike Disease of Sandal (31) Dermaptera & Orthoptera.	L. Chopard & N. C. Chatterjee.	(July 1937.)
29	Immature Stages of Indian Coleoptera (21) Cleridae	J. C. M. Gardner.	(July 1937.)
30	Second Interim Report on Work under Project VIII (Testing of Indian Timbers for Veneer and Plywood)	W. Nagle.	(July 1937.)
OTHER PUBLICATIONS			
31	Annual Return of Statistics relating to Forest Administration in British India, 1934-35	...	October 1936
32	Annual Return of Statistics relating to Forest Administration in British India, 1935-36	...	(In Press.)
33	Forest Research and Indian Industry	...	December 1936
34	Rules for the Grading of Teak Squares (Reprint)	L. N. Seaman & V. D. Limaye	April 1936.
35	Forests in relation to Climate, Water Conservation and Erosion	...	(June 1937.)
36	The Forest Research Institute and College, Central Library, Classified Catalogue, 1934	...	(In Press.)
37	Mercer's Tables (Reprint)	L. Mercer & Nand Mal.	(In Press.)
38	Progress Report on Forest Research work in India, Part I—The Forest Research Institute, 1935-36	....	December 1936
39	Progress Report on Forest Research work in India, Part II—Provincial Reports, 1935-36	...	(May 1937.)
40	Classified List of Forest Officers of the Indian and Provincial Forest Services and of the Indian Forest Engineering Service in India and Burma on 1st July 1936	...	February 1937.
41	Progress Report of the Forest College, Dehra Dun, 1935-36	...	January 1937

CONTRIBUTIONS TO SCIENTIFIC PERIODICALS.

Silviculture.

Laurie, M. V. What are the largest trees in the world? (*Ind. Forester*, March 1936.)

Kakazai, M. A. Dry weight factor for kosh (alder) firewood. (*Ind. Forester*, April 1936.)

Champion, H. G. The regeneration of tropical evergreen forests. (*Ind. Forester*, May 1936.)

Champion, H. G. Ground fires and fertility. (*Ind. Forester*, May 1936.)

Kakazai, M. A. Gradations in thinning intensity. (*Ind. Forester*, June 1936.)

Sen Gupta, J. N. Shade demander *versus* shade bearer. (*Ind. Forester*, June 1936.)

Champion, H. G. Maximum age attained by big timber trees. (*Ind. Forester*, June 1936.)

Sen Gupta, J. N. Best date for pre-monsoon planting of teak stumps. (*Ind. Forester*, July 1936.)

Champion, H. G. Effect of current forest management on future timber supplies. (*Ind. Forester*, August 1936.)

CONTRIBUTIONS TO SCIENTIFIC PERIODICALS—contd

Silviculture—contd.

Sen Gupta, J. N. . . . Regeneration of *gurjan* (*Dipterocarpus*). (*Ind. Forester*, December 1936.)
 Kakazai, M. A. . . . Precision of the standard Indian sample plot method. (*Ind. Forester*, January 1937.)
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 Gardner, J. C. M. . . . A New Indian Species of *Atractocerus* (Col. Lymexylidae). (*Proc. Roy. Ent. Soc. Lond.*, Ser. B., Taxonomy, Vol. V, 1936, p. 181.)
 Gardner, J. C. M. . . . A new species of *Dilhammus* from India (Col. Cerambycidae). (*Proc. Roy. Ent. Soc. Lond.*, Vol. VI, 1937, p. 8.)

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Parkinson, C. E. . . . Flowering of *Bombar malabaricum*. (*Ind. Forester*, March 1936, p. 165.)
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Krishna, S. & Ghose, T. P. . . . Occurrence of *Derris elliptica* in India. (*Current Science*, 1936, Vol. No. 12, pp. 857-859.)
 Krishna, S. & Ghose, T. P. . . . Constituents of the leaves of *Vitis negundo*. (*Journal Ind. Chem. Soc.*, Vol. XIII, No. 10, pp. 634-640.)

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APPENDIX III.

Statement showing Officers-in-charge of Branches and Sections during the year 1936-37.

Branch.	Officer-in-charge.	Section.	Officer-in-charge.	From	To
Silviculture	Mr. H. G. Champion, Silviculturist.	..	..	1-4-1936	31-3-1936
	Mr. M. V. Laurie.	..	..	7-10-1936	31-3-1937
Botany	Mr. C. E. Parkinson, Forest Botanist.	Experimental	Mr. J. N. Sen Gupta	1-4-1936	31-3-1937
	(Dr. K. D. Bagchee)	Statistical	Mr. M. A. Kakozal	1-4-1936	31-3-1937
Utilisation	Mr. H. Trotter, Utilisation Officer.	..	..	1-4-1936	16-11-1936
	Mr. C. E. Parkinson	..	..	17-11-1936	16-3-1937
Entomology	Mr. H. Trotter, Utilisation Officer.	Mycology	Dr. K. D. Bagchee	1-4-1936	31-3-1937
	Mr. H. Trotter	Minor Forest Products	Mr. H. Trotter	1-4-1936	31-3-1937
	Mr. V. D. Limaye.	Timber Testing	Mr. V. D. Limaye. (Mr. S. M. Hasnain)	1-4-1936	30-6-1936
	Mr. V. D. Limaye.	Wood Preservation.	Mr. S. Kamesam	1-7-1936	20-6-1936
	Mr. S. Kamesam	Timber Development.	Mr. S. Kamesam	1-4-1936	31-3-1937
	Mr. S. N. Kapur	Seasoning	Mr. S. N. Kapur	1-4-1936	1-7-1936
	(Mr. M. A. Rahman)		Mr. S. N. Kapur	2-7-1936	3-8-1936
	Mr. M. P. Bhargava	Paper Pulp	Mr. M. P. Bhargava	4-8-1936	31-3-1937
	(Mr. H. Trotter)	Wood Technology.	(Mr. H. Trotter)	1-4-1936	31-5-1936
	Mr. K. A. Chowdhury	Wood Workshop	Mr. K. A. Chowdhury	1-6-1936	31-3-1937
Biochemistry	Mr. W. Nangle		Mr. W. Nangle	1-4-1936	20-3-1937
	(Mr. H. Trotter)		(Mr. H. Trotter)	21-2-1937	31-3-1937
	..		..	3-3-1938	3-4-1938
	..		..	4-4-1936	6-6-1936
Biochemistry	Dr. G. F. C. Betton	..	..	7-6-1936	20-2-1937
	(Mr. J. C. M. Gardner)	..	..	21-2-1937	31-3-1937
	Mr. J. C. M. Gardner	Systematic Entomology.	Mr. J. C. M. Gardner	1-4-1936	31-3-1937
Biochemistry	(Mr. T. P. Ghosh, Officer-in-charge, current duties)	..	..	1-4-1936	16-11-1936
	Dr. S. Krishna	..	..	17-11-1936	31-3-1937

APPENDIX IV.

ANNUAL FORM No. 24.

FOREST RESEARCH INSTITUTE.

Summary of Revenue and Expenditure during 1936-37.

Budget Heads,	Direction.	Silviculture Branch.	Botany Branch	Entomology Branch.	Utilisation Branch.	Chemistry Branch	TOTAL
1	2	3	4	5	6	7	8
REVENUE.							
V.—Miscellaneous—							
(a) Fines and forfeitures .	..	..	..	..	7,350	..	7,350
(b) Other sources . .	700	131	62	49	..	21	662
(c) Leave contribution of officers on foreign service	..	..	..	..	220	..	220
(d) Sale of timber and furniture from seasoning and wood workshop depot	..	..	..	..	1,015	..	1,015
Total Revenue . .	700	131	62	49	8,594	21	9,557
EXPENDITURE.							
A.—Conservancy, Maintenance and Regeneration—							
C. 1.—Purchase of stores, tools and plant	242	473	721	647	691	69	2,843
C. 2.—Communications and Buildings, Repairs and Maintenance.	..	..	..	..	..	..	..
C. 3.—Miscellaneous—							
(1) Temporary Establishment on daily labour.	528	1,072	4,329	2,032	6,187	61	14,800
(2) Purchase of Timber for seasoning and preserving (including freight and carting charges).	..	..	..	..	7,748	..	7,748
(3) Purchase of coal, raw materials, chemicals and apparatus.	..	..	..	..	9,960	1,590	11,690
(4) Other charges . .	202	3,194	1,750	750	18,947	372	25,254
Total A.—Conservancy, Maintenance and Regeneration	982	4,743	6,806	4,160	43,533	2,101	62,344

APPENDIX IV—*contd.*ANNUAL FORM NO. 24—*contd.*FOREST RESEARCH INSTITUTE—*contd.*Summary of Revenue and Expenditure during 1936-37—*contd.*

Budget Heads.	Direction.	Silviculture Branch.	Botany Branch	Entomology Branch.	Utilisation Branch.	Chemistry Branch.	TOTAL.
1	2	3	4	5	6	7	8
Rs. Rs. Rs. Rs. Rs. Rs. Rs. Rs.							
EXPENDITURE—<i>contd.</i>							
B.—Establishments—							
I.—Pay of Officers—							
(a) Superior Officers— Non-voted	25,866	10,400	..	31,813	21,553	..	98,665
(b) Superior Officers— Voted	1,813	14,576	33,808	14,825	1,01,331	14,200	1,80,495
II.—Pay of Establishment	39,050	21,781	9,303	21,002	98,102	9,465	1,00,393
III.—Allowances—							
(b) House Rent and other allowances— Voted	529	..	..	..	..	..	529
Travelling allowances—							
(d) Superior Officers— Non-voted	1,089	2,393	..	2,302	561	..	0,345
Voted—							
(e) Subordinate forest and depot establish- ments.	1,715	2,023	2,270	1,803	7,786	116	10,351
(f) Office establishments							
IV.—Contingencies—							
(a) Stationery	159	1,416	9	71	8		1,603
(b) Carriage of records and tents.	876	550	761	145	215		2,378
(c) Rents, rates and taxes.	6,213	3,612	265	220	..		5,791
(d) Pay of menials . . . . .	..	..	..	..	..		..
(e) Official postage	2,147	298	320	302	187	24	4,028
(f) Sundries	11,794	358	4,076	831	1,715	102	16,411
(g) Clothing and uni- forms.	128	60	82	162	310	15	1,112
(h) Telephones	1,110	338	321	270	1,022	162	3,629

APPENDIX IV—*concl.*ANNUAL FORM NO. 24—*concl.*FOREST RESEARCH INSTITUTE—*concl.**Summary of Revenue and Expenditure during 1936-37—concl.*

Budget Heads.	Direction	Agriculture Branch	Botany Branch	Entomology Branch	Utilisation Branch	Chemistry Branch	TOTAL
1	2	3	4	5	6	7	8
EXPENDITURE— <i>concl.</i>	Rs	Rs	Rs	Rs	Rs	Rs	Rs
B—Establishments— <i>concl.</i>		6 ⁰ 4	.	1,200	600		2,434
V—Cost of passage granted under Superior Civil Service Rules 1924 (Non voted)							
Total B—Establishments	92,020	61,492	49,040	77,705	2,35,102	21,060	5,30,447
GRAND TOTAL OF ALL EXPENDITURE UNDER 8—FOURTS.	91,018	60,315	51,955	81,874	2,78,035	21,070	5,08,787
Major Head 8-A—Share of Capital Charges financed from ordinary revenue.	.	1,000	.	..	2,246	..	3,336
Surplus or deficit	—92,318	—67,294	—51,703	—81,825	—2,72,287	—24,040	—5,02,566

Note—The figures given in this statement have been prepared in the President's office and are based on the Summary of Revenue and Expenditure for March 1937 received from the Accountant General, Central Revenues. They do not include certain adjustments made in March final accounts by the Accountant General, Central Revenues, on account of late entry, exchange accounts with other Governments and expenditure incurred through the High Commissioner on Miscellaneous Items.

GERALD TREVOR,
President,
Research Institute and College.

